ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

# Review of Historical Knowledge Related to Metals and Select Radionuclides Identified as Environmental Media Analytes of Interest

## White Paper

**Rocky Flats Environmental Technology Site**
**10808 Highway 93**
**Golden, CO 80403-8200**

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1/46

# TABLE OF CONTENTS

## LIST OF TABLES



## LIST OF FIGURES

# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AEU | Aquatic Exposure Unit |
| AL | action level |
| AOI | analyte of interest |
| BZ | Buffer Zone |
| CAA | Clean Air Act |
| CDH | Colorado Department of Health |
| CDPHE | Colorado Department of Public Health and Environment |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CESC | Citizens Environmental Sampling Committee |
| CHWA | Colorado Hazardous Waste Act |
| CRA | Comprehensive Risk Assessment |
| DOE | U.S. Department of Energy |
| EPA | Environmental Protection Agency |
| ER | Environmental Restoration |
| EU | Exposure Unit |
| GW | Groundwater |
| HAER | Historic American Engineering Record |
| HCl | hydrochloric acid |
| HEPA | high-efficiency particulate air |
| HRR | Historical Release Report |
| IA | Industrial Area |
| IABZSAP | Industrial Area and Buffer Zone Sampling and Analysis Plan |
| IHSS | Individual Hazardous Substance Site |
| IM/IRA | Interim Measure/Interim Remedial Action |
| K-H | Kaiser-Hill Company, L.L.C. |
| kg | kilogram |
| ug/L | micrograms per liter |
| mg/day | milligrams per day |
| mg/kg | milligrams per kilogram |
| NA | Not Applicable |
| ND | Not Detected |
| NESHAP | National Emission Standard for Hazardous Air Pollutants |
| NLR | No Longer Representative |
| ORPS | Occurrence Reporting and Processing System |
| PAC | Potential Area of Concern |
| pCi/g | picocuries per gram |
| PCOC | potential contaminant of concern |
| PDSR | Pre-Demolition Survey Report |
| ppm | parts per million |
| PRG | preliminary remediation goal |
| R&D | Research and Development |
| RCRA | Resource Conservation and Recovery Act |

| | |
|---|---|
| RFCA | Rocky Flats Cleanup Agreement |
| RfD | reference dose |
| RFETS | Rocky Flats Environmental Technology Site |
| RFO | Rocky Flats Office |
| RI/FS | Remedial Investigation/Feasibility Study |
| RLCR | Reconnaissance-Level Characterization Report |
| RSOP | RFCA Standard Operating Protocol |
| SAP | Sampling and Analysis Plan |
| SEPs | Solar Evaporation Ponds |
| UBC | Under Building Contamination |
| UST | underground storage tank |
| VOC | volatile organic compound |
| WEMS | Waste and Environmental Management System |
| WRW | wildlife refuge worker |
| WSRIC | Waste Stream and Residue Identification and Characterization Reports |
| ZPPR | Zero Power Plutonium Reactor |

## 1.0 INTRODUCTION

This paper presents a review of information to support a weight-of-evidence determination toward eliminating certain analytes of interest (AOIs) in the Comprehensive Risk Assessment (CRA) potential contaminant of concern (PCOC) professional judgment screening step, on a Sitewide or Exposure Unit (EU)/Aquatic Exposure Unit (AEU) basis. This paper will also be used to supplement evaluations in the Groundwater Interim Measure/Interim Remedial Action (GW IM/IRA) and the nature and extent of contamination sections of the Remedial Investigation /Feasibility Study (RI/FS) Report. The decision to eliminate an AOI from further evaluation will be decided in the GW IM/IRA, and in the specific portions of the RI/FS Report such as the CRA and the nature and extent sections. The information in this paper will be used to supplement the professional judgment decisions within each of these decision documents.

Twenty-four AOIs have been identified in the soil and groundwater nature and extent of contamination evaluations (preliminary reviews), and in sediment and surface water, above preliminary remediation goals (PRGs)[1]. These AOIs are composed of 20 metals (other than beryllium, which was used extensively at the Rocky Flats Environmental Technology Site [RFETS]) and four radionuclides (other than americium, plutonium, and uranium isotopes, which were used extensively at RFETS), as listed in Table 1. The reasonably anticipated future land use is a wildlife refuge, therefore Wildlife Refuge Worker (WRW) PRGs were developed using a Hazard Quotient of 0.1 or risk of $1x10^{-6}$ (The more conservative of the two values were used for the PRG). The WRW PRGs were developed specifically for the CRA and are identified in the CRA Methodology (DOE 2004), which has been approved by the Environmental Protection Agency, Region VIII (EPA) and the Colorado Department of Public Health and Environment (CDPHE). WRW PRGs and professional judgment are screening tools used in the CRA and in the RI/FS Report.

Table 2 indicates whether an AOI is addressed in the following sources of information that were reviewed:

- Health Studies on RFETS Phase I: Historical Public Exposures, conducted by ChemRisk for the Colorado Department of Health (CDH) (an independent investigation of off-site health risks associated with operations at RFETS):
    - Project Task 1 Report: Identification of Chemicals and Radionuclides Used at Rocky Flats, March 1991,
    - Project Task 2 Report: Selection of the Chemicals and Radionuclides of Concern, June 1991,
    - Project Tasks 3 & 4 Report: Reconstruction of Historical Rocky Flats Operations & Identification of Release Points, August 1992, and
    - Project Task 5 Report: Estimating Historical Emissions from Rocky Flats 1952-1989;

Building Rocky Flats Cleanup Agreement (RFCA) Reconnaissance Level Characterization Reports (RLCRs) and Pre-Demolition Survey Reports (PDSRs);

[1] The list of surface water AOIs will be updated after a comparison to surface water standards is performed in the surface water nature and extent of contamination evaluation.

## Table 1 Preliminary AOIs by Medium

| Soil[a] | | Sediment[a] | Surface Water[a] | Groundwater[b] | | AOIs Evaluated |
|---|---|---|---|---|---|---|
| Surface Soil | Subsurface Soil | | | UHSU | LHSU | |
| **Metals** | | | | | | |
| Aluminum | | Aluminum | | | | Aluminum |
| Antimony | | Antimony | | | | Antimony |
| Arsenic | Arsenic | Arsenic | Arsenic | | | Arsenic |
| | | | | | | Barium |
| Cadmium | | | | | | Cadmium |
| Chromium | Chromium | Chromium | | Chromium (total) | | Chromium |
| Cobalt | | | | | | Cobalt |
| | | | | | | *Copper* |
| Iron | | Iron | | | | Iron |
| | Lead | | | | | Lead |
| | | | | | | *Lithium* |
| Manganese | | Manganese | | Manganese (dissolved) | | Manganese |
| Mercury | | | | | | Mercury |
| | | | | | | *Molybdenum* |
| | | | | Nickel (dissolved) | | Nickel |
| | | | | Selenium (dissolved) | | Selenium |
| | | | | | | *Strontium* |
| | | | Thallium | | | Thallium |
| Vanadium | | | | | | Vanadium |
| | | | | | | *Zinc* |
| **Radionuclides** | | | | | | |
| Cesium-137 | | Cesium-137 | | | | Cesium-137 |
| | | | | | | *Strontium-89/90* |
| | | Radium-226 | | Radium-226 + Radium-228 (total) | | Radium-226 |
| Radium-228 | Radium-228 | Radium-228 | | | | Radium-228 |

Note: Although barium, lithium, molybdenum, selenium, strontium and zinc (in *italics* in the last column) are not identified as an AOI in a specific medium, they have been identified in the CRA process and as a result are included in this report.

[a] AOIs in surface soil, subsurface soil (based on June 30, 2005 draft report), surface water and sediment are those analytes present above a $1x10^{-6}$ WRW PRG.

[b] AOIs in groundwater are those analytes present above either a surface water standard or an MCL and form a contiguous plume (based on June 9, 2005 draft report).

## Table 2 AOI Usage at RFETS

| AOIs | Inventory in RFETS Buildings[a] | Waste Generated in Buildings[b] | Spills/ Releases Within Buildings[c] | Spill/Release Required Action Prior to Demolition[d] | IHSSs/PACs/UBCs Requiring an Accelerated Action[e] | Material of Concern as Selected by ChemRisk Task 2 | Material of Concern as Selected by ChemRisk Tasks 3&4 |
|---|---|---|---|---|---|---|---|
| Aluminum | X | X | | | | | |
| Antimony | X | X | | | | | |
| Arsenic | X | X | | | X | | |
| Barium | X | X | | | | | |
| Cadmium | X | X | X | | | X | |
| Chromium (total) | X | X | X | | X | X | |
| Cobalt | X | | | | | | |
| Copper | X | X | | | | | |
| Iron | X | | | | | | |
| Lead | X | X | X | | X | X | |
| Lithium | X | X | X | | | | |
| Manganese | X | | | | | | |
| Mercury | X | X | X | | | X | |
| Molybdenum | X | X | | | | | |
| Nickel | X | X | X | | | X | |
| Selenium | X | X | | | | | |
| Strontium | X | | | | | | |
| Thallium | X | X | | | | | |
| Vanadium | X | X | | | | | |
| Zinc | X | X | | | | | |
| Cesium-137 | X | X | | | | | |
| Radium-226 | X | X | | | | | |
| Radium-228 | | | | | | | |
| Strontium-89/90 | X | X | | | | | |
| | Thorium-232[f] | X | | | | X | X |

[a] Based on the ChemRisk Task 1 Report (CDH 1991) and on historical information summarized in the IABZSAP (DOE 2004).
[b] Based on the RFETS RCRA Permit, WSRIC, and WEMS (also includes whether underlying hazardous constituents were identified) (See Table 4).
[c] Based on information found in RLCRs and PDSRs (see Tables 3 and 4 for details).
[d] Sampling of building materials prior to demolition indicated all metal concentrations were below regulatory limits and did not require decontamination or removal.
[e] Based on SAPs, SAP Addenda or Closeout Reports for specific IHSS Groups (See Table 5 for details).
[f] AOI radium-228 is in the thorium-232 decay chain.

- RFETS Resource Conservation and Recovery Act (RCRA)/Colorado Hazardous Waste Act (CHWA) Facility Permit, the Waste Stream and Residue Identification and Characterization (WSRIC) reports, and the Waste and Environmental Management System (WEMS) reports;

- Industrial Area (IA) and Buffer Zone (BZ) SAP (IABZ SAP) Appendix C (to supplement ChemRisk Reports); and

- RFCA Accelerated Action Sampling and Analysis Plans (SAPs), SAP Addenda, and Closeout Reports.

### 1.1 ChemRisk Tasks 1 through 5 Reports

ChemRisk conducted an independent 2-year investigation of off-site health risks associated with operations of the Rocky Flats Plant for the CDH (Tasks 1 through 12). This investigation generated an inventory of chemicals and radionuclides that have been used or produced at RFETS. This information was screened in various Task Reports to identify a "short list" of chemicals that, because of the amounts, processes, and duration of use, should be evaluated for off-site release potential.

The buildings[2] identified in the Task 3 & 4 ChemRisk report formed the basis for evaluating the usage of the AOIs in this review.

ChemRisk Task 1 involved the identification of chemicals and radionuclides that have been used on-site. For these chemicals, a three stage screening process was developed to narrow down the list of potential materials of concern. Initially, over 8,000 chemicals were identified in the Task 1 Report. Screening stages were developed in the Task 2 Report to help evaluate the list of chemicals, based on such factors as the relative toxicity of the materials, quantities used, how the materials might have been released into the environment, and the likelihood for transport of the materials off-site. In the first stage, 629 compounds were identified for further, more refined screening as potential materials of concern (as defined by the ChemRisk process based on materials in inventory, which may pose an off-site health risk) based on their known toxicologic properties, RFETS release histories, or reported inventory quantities. (Material of concern is defined by the ChemRisk process as the inventory of materials used at RFETS, which could pose an off-site health risk.) A second stage of screening was performed to roughly estimate if the quantity of a chemical on-site was sufficient to pose an off-site health hazard. Forty-six potential chemicals of concern emerged from Stage 2 screening. In the final stage of screening, these chemicals were individually evaluated to determine the likelihood of their release and potential quantity of release based on actual storage and usage practices, likely routes of release, and known behavior in the environment. Based on this final screen a total of 25 materials of concern were identified in the Task 2 Report and further evaluated in the Task 3 & 4 Report. Of these 25, only five metals (Table 2) were identified and eventually dropped in the Task 3&4 Report.

[2] The buildings discussed in the ChemRisk reports are presented later in this report in Tables 3 and 4.

## 1.2 RLCRs and PDSRs

To supplement the historic usage information, building specific information from RLCRs and PDSRs were used to identify any contaminants that may have been present in buildings (discussed in the ChemRisk Reports) prior to demolition (including spills or releases) or, in the case of Type 2 or 3 buildings, were the basis of a hazard profile analysis for a building (Table 3). A building has never been classified as either a Type 2 or 3 building based on the presence of any of the AOI metals or radionuclides. The Type 2 and 3 classifications were primarily based on the presence of beryllium and/or americium, plutonium, or Uranium radionuclides. In addition, all RCRA units within buildings were either certified clean-closed or were closed by removal prior to demolition. (Additional information is presented below regarding the history of RCRA units.)

## 1.3 RCRA/CHWA Facility Permit, WSRIC Reports and WEMS Reports

Hazardous waste (including mixed waste) management activities were conducted in many buildings at RFETS. Table 4 lists the hazardous wastes managed in buildings (discussed in the ChemRisk Reports). A review was conducted of the RFETS RCRA/CHWA Operating Permit, as well as the waste[3] generated from the various buildings as identified in the WSRIC Reports and the WEMS Reports (part of the RCRA operating record used to track and control inventory and movement of hazardous, nonhazardous, and mixed waste containers). Based on process knowledge, RCRA waste codes were conservatively applied to wastes generated within the buildings. For example, if the possibility existed for one building to generate a RCRA waste, all process buildings were identified to also carry this waste code in case waste was transferred via process waste lines or moved into a separate building for storage and/or treatment or if analysis was required on the waste. Also, historically, RCRA waste codes were conservatively applied to materials without specific attention given to concentration (when mixtures were involved) or to the process generating the waste.

Specific units were permitted under the RFETS RCRA/CHWA Operating Permit or were operated under RCRA/CHWA Interim Status requirements, pending their closure. Closure of permitted and interim status units is governed under the Colorado Department of Public Health and Environment (CDPHE) approved closure plans. The focus of closure plans is to ensure that any hazardous wastes in the unit have been removed and that any unit components with residual wastes are properly decontaminated or removed, resulting in unit clean closure. Documentation that wastes have been removed and all necessary decontamination and component removal have been conducted was submitted to CDPHE for approval of the unit closure. While spills related to some units may have occurred during operations, the permit and interim status requirements governed the appropriate cleanup response action, including decontamination if necessary, taken at the time. These actions prevented any significant impacts by prompt and effective removal of spilled hazardous wastes.

The RLCRs include information on hazardous waste units, characterization of residual hazardous wastes, and unit closure. Inspection and characterization of these units indicated residual hazardous waste contamination was basically confined to unit components, such as tanks, piping, floors, and floor coverings and sumps designed to contain these wastes during waste management activities. The units were properly closed prior to building decommissioning in accordance with

[3] This review was conducted based on RCRA waste codes and included all waste that may have carried a specific waste code. This review also looked at any waste associated with non-RCRA metals such as aluminum.

## Table 3 History of AOIs Used in RFETS Buildings

| AOIs | 371 [a,b,d] | 374[a,b,d] | 444[a,b] | 445[b,c] | 450[b,c] | 455[b,c] | 460[b,d] | 559[a,b] (Lab) | 561[b,c] | 707[a,b] | 712/ 713[b,c] | 774[a,b] | 771[a,b] | 776/ 777[b,c] | 779[b,c] (Lab) | 881[b,c] (Lab) | 883[b,c] | 865[b,c] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Metals** | | | | | | | | | | | | | | | | | | |
| Aluminum | | | X | | | | | | | X | | | X | | X | | X | X |
| *Antimony*[e] | | | | | | | | | | | | | | | | | | |
| ***Arsenic***[e] | | | | | | | | | | | | | | | | | | |
| ***Barium*** | | | | | | | | | | | | | | | | | | |
| **Cadmium** | | | X | | | | | X | X | X | | X | X | X | | X | X | |
| **Chromium (total)** | X | X | X | | | | X | X | X | | X | X | | X | X | | | |
| *Cobalt*[e] | | | | | | | | | | | | | | | | | | |
| Copper | | | X | | | | | | | | | | | | X | X | X | X |
| Iron | X | | X | X | X | X | | | | | | | | | | | | |
| **Lead** | X | X | | | | | | X | | X | | X | X | X | | | | |
| Lithium | | | | | | | | X | | X | | | | X | | X | | |
| *Manganese* | | | | | | | | | | | | | | | | | | |
| **Mercury** | | | | | | | | X | X | | | | | X | | X | | |
| Molybdenum | | | X | | | | | | | | | | X | X | | | | X |
| Nickel | X | X | X | | | | | | | | | X | X | X | X | X | | |
| ***Selenium***[e] | | | | | | | | | | | | | | | | | | |
| *Strontium*[e] | | | | | | | | | | | | | | | | | | |
| *Thallium*[e] | | | | | | | | | | | | | | | | | | |
| Vanadium | | | X | | | | | | | X | | | | | X | X | X | X |
| *Zinc* | | | | | | | | | | | | | | | | | | |
| **Radionuclides** | | | | | | | | | | | | | | | | | | |
| *Cs-137*[e] | | | | | | | | | | | | | | | | | | |
| *Ra-226*[e] | | | | | | | | | | | | | | | | | | |
| Ra-228 | | | | | | | | | | | | | | | | | | |
| Sr-89/90[e] | | | | | | | | | | | | | | | X | | | |
| Thorium-232 | | | | | | | | | | | | | X | | | X | | |

Note those AOIs identified in *Italic type* above indicate that these were included in the ChemRisk inventories for the Site, however there were no specific building identified. Those AOIs identified in **bold type** indicate RCRA metals.

Footnotes are based on PDSRs, RLCRs and Historical Site Assessment Reports (attached to RLCR).

Lab = Laboratory

a Spills occurred, areas sampled and results indicate all concentrations below RCRA regulatory limits for RCRA metals.
b Buildings contained RCRA units which were closed by demonstrating clean closure or closure by removal.
c No known spills of RCRA/CERCLA contaminants.
d PDSRs for all phases of work are currently not available.
e These AOIs were identified in very small quantities associated with laboratory operations and used as laboratory standards or in analytical testing.

## Table 4 Waste containing AOI generated in RFETS Buildings

| AOIs | 371 | 374 | 444 | 445 | 450 | 455 | 460 | 559 | 561 | 707 | 712/713 | 771 | 774 | 776/777 | 779 | 881 | 883 | 865 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Metals** | | | | | | | | | | | | | | | | | | |
| Aluminum | X[a] | | | | | | | X | | X[a] | | | | | X | | | |
| Antimony | | | | | | | | X[b] | | | | | | | | | | |
| **Arsenic** | X | X | | | | | X | X | | X | | X | X | X | X | X | X | X |
| **Barium** | X | X | X[b] | | | | | X | | X | | X | X | X | X | X | X | X |
| **Cadmium** | X | X | X | | | | X | X | | X | | X | X | X | X | X | X | X |
| **Chromium (total)** | X | X | X | | | | X | X | | X | | X | X | X | X | X | X | X |
| Cobalt | | | | | | | | | | | | | | | | | | |
| Copper | | | | | | | | X | | | | | | | | X | | |
| Iron | | | | | | | | | | | | | | | | | | |
| **Lead** | X | X | X | | | | X | X | | X | | X | X | X | X | X | X | X |
| Lithium | X[c] | | X[c] | | | | X[c] | X | | | | X[c] | | | | X | X | |
| Manganese | | | | | | | | | | | | | | | | | | |
| **Mercury** | X | X | X | | | | X | X | | X | | X | X | X | X | X | X | X |
| Molybdenum | | | | | | | | X | | | | | | | | | | |
| Nickel | X[b] | X[b] | X[b] | | | | | X[b] | | X[b] | | X[b] | X[b] | X[b] | X[b] | X[b] | X[b] | X[b] |
| **Selenium** | X | X | X | | | | | X | | X | | X | X | X | X | X | X | X |
| Strontium | | | | | | | | | | | | | | | | | | |
| Thallium | | | | | | | | X[b] | | X[b] | | X[b] | | | X[b] | X[b] | | |
| Vanadium | | | | | | | | X[b] | | | | | | | | X[b] | | |
| Zinc | | | | | | | | | | | | | | | | X[b] | | |
| Radionuclides | | | | | | | | | | | | | | | | | | |
| *Cesium-137* | | | | | | | | | | X[d] | | | | X[d] | | | | |
| *Radium-226* | | | | | | | | | | X[d] | | | | X[d] | | | | |
| Radium-228 | | | | | | | | | | | | | | | | | | |
| Strontium-89/90 | | | | | | | | | | X[d] | | | | | | | | |
| Thorium-232 | | | | | | | | | | | | | | | | X[d] | | |

Note those AOIs identified in **bold type** above indicate RCRA metals.
Footnotes are based on printouts from WSRIC.

[a] Aluminum oxide and magnesium oxide crucibles.
[b] Analyte was identified as an underlying hazardous constituent and not as a RCRA toxicity metal waste.
[c] Waste consisted of Lithium batteries.
[d] Sealed sources were removed as waste from this building.

the permit or interim status closure plans, or as part of the decommissioning process under the RFCA decision documents and closures approved by CDPHE. Thus, RCRA/CHWA closure activities did not indicate any significant releases of hazardous wastes from these units. The WEMS database was implemented in 1990 and the WSRIC database in January 2002[4]. Any information regarding wastes and any spills resulting in wastes prior to this time would have been included in the evaluation performed by ChemRisk and by the Environmental Restoration (ER) program.

## 1.4 IABZ SAP, Appendix C

Appendix C of the IABZ SAP contains historical building process information summarized from the 1998 Historic American Engineering Record (HAER) (for the Rocky Flats Historic District). This information was used to supplement chemical usage information from the ChemRisk reports.

## 1.5 SAPs, SAP Addenda, and Closeout Reports

A summary is provided in Table 5 based on SAPs, SAP Addenda, and Closeout Reports for Individual Hazardous Substance Sites (IHSSs), Potential Area of Concern (PACs) or Under Building Contamination (UBCs) sites to indicate whether the presence of metals in the environment were identified above RFCA action levels (ALs), and were removed under an IHSS accelerated action.

**Table 5 Metals requiring an accelerated action at IHSSs/PACs/UBC Sites**

| IHSS Group | IHSS/PAC/UBC Site | Building/ Structure | Metal Requiring Action |
|---|---|---|---|
| 700-6 | PAC 700-137 (Cooling Tower Blowdown) | Buildings 712/713 | Arsenic |
| 100-4 | UBC 123 | Building 123 | Lead |
| 400-8 | PAC 400-122 | UST associated with Building 441 | Lead |
| 500-2 | PAC 500-158 | Building 551 | Chromium |
| 700-2 | No specific IHSS | Outside of Building 707 | Arsenic |
| NE-1 | PAC NW-1505 | North Firing Range | Lead |
| 900-11 | PAC SE-1602 | East Firing Range | Lead and Arsenic |

In addition to the buildings identified in the ChemRisk reports and presented in Tables 3 and 4, potential UBC sites (that were not included in the ChemRisk buildings) have also been added and presented in Tables 6 and 7. These buildings were added due to the potential contamination

[4] Although the WSRIC database was not implemented until 2002, building books were started in 1991 and this information was included in the database.

## Table 6 History of AOIs Used in UBC Sites

| AOIs | 122 [c,e] | 123 [a,b] Lab | 125 [a] Lab | 331[c] | 439[c] | 440[d] | 441[a] | 442 | 447[a,b] | 528 [a,b] | 701 [d] | 731 [a,b,d] | 770 | 778 | 886 Lab | 887[a,b] | 889 | 991[b,c] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Metals** | | | | | | | | | | | | | | | | | | |
| Aluminum | | | | | | | | | X | | | | | | | | | |
| Antimony[e] | | | | | | | | | | | | | | | | | | |
| **Arsenic**[e] | | | | | | | | | | | | | | | | | | |
| **Barium** | | | | | | | | | | | | | | | | | | |
| **Cadmium** | | X | | | | | | | | X | | X | | | | | | |
| **Chromium (total)** | | X | | | | | | | | X | | X | | | | | | |
| Cobalt[e] | | | | | | | | | | | | | | | | | | |
| Copper | | | | | | | | | | | | | | | | | | |
| Iron | | | | | | | | | | | | | | | | | | |
| **Lead** | | X | | | | | | | | X | X | X | | | | | | |
| Lithium | | | | | | | | | | | | | | | | | | |
| Manganese | | | | | | | | | | | | | | | | | | |
| **Mercury** | | | | | | | | | | | | | | | X | | | |
| Molybdenum | | | | | | | | | | | | | | | | | | |
| Nickel | | | | | | | | | | | | | | | | | | X |
| **Selenium**[e] | | | | | | | | | | | | | | | | | | |
| Strontium[e] | | | | | | | | | | | | | | | | | | |
| Thallium[e] | | | | | | | | | | | | | | | | | | |
| Vanadium | | | | | | | | | X | | | | | | | | | |
| Zinc | | | | | | | | | | | | | | | | | | |
| **Radionuclides** | | | | | | | | | | | | | | | | | | |
| Cs-137[e] | | | | | | | | | | | | | | | X | | | |
| Ra-226[e] | | | | | | | | | | | | | | | | | | |
| Ra-228 | | | | | | | | | | | | | | | | | | |
| Sr-89/90[e] | | | | | | | | | | | | | | | | | | |
| Thorium-232 | | | | | | | | | | | | | | | | | | |

Note those AOIs identified in **bold type** indicate RCRA metals.
Footnotes are based on PDSRs, RLCRs, Closeout Reports and/or Historical Site Assessment. Reports (attached to RLCR).
Lab = Laboratory

a Spills occurred, areas sampled and results indicate all concentrations below RCRA regulatory limits for RCRA metals.
b Buildings contained RCRA units which were closed by demonstrating clean closure or closure by removal.
c No known spills of RCRA/CERCLA contaminants.
d PDSRs and/or Closeout Reports for all phases of work are currently not available.
e These AOIs were identified in very small quantities associated with laboratory operations and used as laboratory standards or in analytical testing.

## Table 7 Waste containing AOI generated in UBC Sites

| AOIs | 122 | 123 | 125 | 331 | 439 | 440 | 441 | 442 | 447 | 528 | 701 | 731 | 770 | 778 | 886 | 887 | 889 | 991 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Metals** | | | | | | | | | | | | | | | | | | |
| Aluminum | | | | | | | | | | | | | | X[a] | | X[a] | | |
| Antimony | | | | | | | | | | | | | | | | | | |
| **Arsenic** | | | | | | | | | | | | | | X | | X | X | |
| **Barium** | | | | | X | | | X[b] | | | | | | X | X | X | | |
| **Cadmium** | X | X | X | X | X | X | X[b] | X[b] | | | X | | | X | X | X | | X |
| **Chromium (total)** | X[b] | X | | X | X | X | X[b] | | X | | X | | | X | X | X | | X |
| Cobalt | | | | | | | | | | | | | | | | | | |
| Copper | | | | | | | | | | | | | | | | | | |
| Iron | | | | | | | | | | | | | | | | | | |
| **Lead** | X | X | X | X | X | X | | X | X | | X | | X | X | X | X | X | X |
| Lithium | | | X[c] | | | | | | | | | | | X[c] | | | | |
| Manganese | | | | | | | | | | | | | | | | | | |
| **Mercury** | | X | X | X | X | X | | X | | | X | | X | X | X | X | X | X |
| Molybdenum | | | | | | | | | | | | | | | | | | |
| Nickel | X[b] | | X[b] | X[b] | X[b] | | | X[b] | | | X[b] | | | X[b] | X[b] | | | X[b] |
| **Selenium** | | | | | X | | X[b] | | | | | | | | | X | | |
| Strontium | | | | | | | | | | | | | | | | | | |
| Thallium | | | | | | | | | | | | | | | | | | |
| Vanadium | | | | | | | | | | | | | | | | | | |
| Zinc | | | | | | | | | | | | | | | | | | |
| Radionuclides | | | | | | | | | | | | | | | | | | |
| *Cesium-137* | | | | | | | | | | | | | | | | | | X[d] |
| *Radium-226* | | | | | | | | | | | | | | | | | | |
| Radium-228 | | | | | | | | | | | | | | | | | | |
| Strontium-89/90 | | | | | | | | | | | | | | | | | | X[d] |
| Thorium-232 | | | | | | | | | | | | | | | | | | |

Note those AOIs identified in **bold type** above indicate RCRA metals.
Footnotes are based on printouts from WSRIC.

[a] Aluminum silicate (clay) identified to be associated with "combustibles contaminated with adhesives".
[b] Analyte was identified as an underlying hazardous constituent and not as a RCRA toxicity metal waste.
[c] Waste consisted of Lithium batteries.
[d] Sealed sources were removed as waste from this building.

of soil identified or suspected under specific buildings from broken process waste lines or other sources. The information used to complete these tables is the same information as described in sections 1.2 through 1.4 and from the site Historical Release Report (HRR) (DOE 1992).

Additional sources of information that were reviewed but did not identify metal concerns are discussed below.

### 1.6 Compliance Review under the CAA

National Emission Standards for Hazardous Air Pollutants (NESHAPs), developed pursuant to the Clean Air Act (CAA), have not been applicable to any processes on Site involving the usage of metals. In addition, emission calculations for specific processes (for example, Building 443 boiler emissions from fuel consumption) have consistently[5] indicated metal concentrations are below any reporting threshold.

### 1.7 ORPS

A review of the Occurrence Reporting and Processing System (ORPS) occurrence reports was conducted (from 1991 to current) for emergencies at RFETS that required implementation of either the Site emergency plan or the Site RCRA contingency plan involving buildings and spill/releases into the environment. For occurrence reporting prior to 1991, no electronic system was available, and lists of occurrences, event reporting, health and safety issues, and serious incidence reports were reviewed instead for the time period between 1952 and 1990. Very few documented incidents (within a span of 50 years) occurred within a building that would have resulted in a release to the environment. Of those incidents that could have impacted the environment, all were historically identified as an IHSS, PAC, or UBC Site and evaluated to determine if an accelerated action was needed. All accelerated actions have resulted in a No Further Accelerated Action (NFAA) determination.

Between 1991 and the present, only three occurrences were reported that potentially involved a release of an AOI outside of a building. These occurrences resulted in either no impact to the environment or no significant impact to the environment.

In 1993 there was a sprinkler head malfunction in Room 3189 (a radiological material area) of Building 374, releasing firewater that eventually ran onto Dock 18T and onto the ground. Sample results determined the water was clean and approved for release to the stormdrain system. There was no impact to the environment (RFO 1993 in Appendix A, Occurrence Reports).

In 1998 approximately 1 gallon of phosphoric acid contaminated with depleted uranium was released from a dock drain line into a bermed area from Tank D-843 at Building 371. The occurrence report indicated there was no impact to the environment (RFO 1998 in Appendix A). Characterization data around the 371 dock did not indicate any uranium concentrations greater than background mean plus two standard deviations, based on the SAP Addendum for IHSS Group 300-3 (DOE 2003a).

[5] A thorough evaluation of emission inventories began at RFETS in late 1989.

In 2002 there was a spill of low-level mixed waste from a RCRA-regulated tank located south of Buildings 371/374. Approximately 1 to 5 gallons of waste were released outside the secondary containment over an area of approximately 600 square feet. Analytical results for all RCRA metals were below regulatory limits, with cadmium results being the highest at 104 micrograms per liter (µg/L) (parts per billion) (RFO 2002 in Appendix A). This spill was remediated as part of accelerated actions at RFETS.

## 2.0 SUMMARY OF INFORMATION AVAILABLE FOR AOIs

Based on the various categories of information reviewed (including the ChemRisk reports), a summary is provided below for each of the 23 AOIs.

Figures 1 through 22 provide soil sampling and analysis results for data (June 28, 1991 through April 27, 2005) greater than background mean plus two standard deviations (as defined in Attachment 2, Volume 2 of 15, Appendix A of the RI/FS Report (DOE 2005a) beneath the slabs[6] at UBC sites and surface soil data around the buildings. This data conservatively represent the contaminants that remain, since more accelerated actions have been completed (after April 27, 2005) at the site resulting in more data becoming no longer representative (NLR).

Tables 8 through 27 provide summary statistics for the UBC soil analytical results, including a comparison to surface soil background mean plus two standard deviations (for Buildings 371, 374, 444, 559, 561, 707, 771, 774, 776, 777, 779, 865, 881, and 883). The remaining buildings for which UBC investigations were conducted have also been included in both figures and tables. These include Buildings 122, 123, 125, 331, 439, 440, 441, 442, 447, 528, 701, 731, 770, 778, 886, 887, 889, and 991. Although Buildings 125, 460, 561, 731 and 887 were included, there is no data reported in Tables 8 through 27 for the following reasons:

- Building 125 received a no further accelerated action determination;
- Building 460 was not expected to have contamination beneath the slab;
- Building 561 was not identified as a UBC building;
- Samples were collected around Building 731 at depths below the slab, but not beneath the slab since groundwater would have been encountered under artesian conditions; and
- Building 887 samples were moved to the outside of the building footprint because of concerns with groundwater beneath the building.

The figures[7] and tables indicate a significant portion of AOI mean concentrations are below background mean plus two standard deviations (antimony, arsenic, barium, cadmium, lead, manganese, mercury, molybdenum, selenium and zinc). For aluminum, chromium, cobalt, iron, lithium, nickel, strontium, and vanadium, the mean concentrations are within or very closely approximate background. In reviewing the figures, the horizontal spatial distribution of AOI concentrations do not indicate large areas of soil with concentrations that exceed background, and point to a very limited surficial soil or UBC deposition. For copper, and thallium a majority

[6] Data includes samples at depth intervals of 0 to 0.5 feet beneath the building slabs. Also included were samples collected at a depth interval of 0 to 2.5 feet or 3.0 feet, if this was the uppermost sample interval beneath the slab.

[7] Each figure identifies concentrations of metals greater than the WRW PRG ($1x10^{-6}$ risk level) and 10 times WRW PRG ($1x10^{-5}$ risk level).

of the mean concentrations beneath UBCs are above background (but below RFCA action levels for accelerated actions).

Based on extensive experience in soil removal at IHSSs, such limited areas of elevated surficial and UBC concentrations indicate subsurface migration of AOIs at higher concentrations would not be expected. Rather, this experience indicates generally that concentrations significantly decrease with depth (metals if soluble are influenced by the chemistry of the soil [for example, pH, the presence of other metals and oxygen] and do not move significantly in the subsurface). It is unlikely that these limited elevated concentration locations result in subsurface soil contamination or present a source of groundwater contamination.

## 2.1 Metals

A total of 20 metal AOIs have been identified in media based on the nature and extent evaluations. These metals are discussed in the following sections.

### 2.1.1 Aluminum

Aluminum was used primarily in various metallurgical operations within Buildings 444, 779, 865, and 883 (CDH 1992; DOE 2004). Rejected aluminum parts were disassembled and recycled or prepared for disposal in Building 707. Aluminum was also used in pit construction (Building 707). In Building 447 materials handled included stainless steel, beryllium, aluminum, depleted uranium, and vanadium compounds. Aluminum nitrate was used in an aqueous dissolution process within Building 771 for plutonium recovery.

All of the buildings identified above (except Building 778 [Plant Laundry Facility]) involved radiological operations and included extensive high efficiency particulate air (HEPA) filtration systems. Any particulates or fines from machining aluminum metals would have been collected on these filters prior to release from the buildings. (Building 887 was used to manage process and sanitary waste, and Building 778 laundered clothing. These buildings did not machine aluminum metal.)

Aluminum was identified in the ChemRisk reports as a chemical (for example, aluminum nitrate) and not as a metal (CDH 1991a). Aluminum nitrate was not carried forward as a material of concern for the ChemRisk reports based on ingestion of this material in a drinking water exposure scenario for off-site receptors (CDH 1991b).

There is no record of spills involving aluminum nitrate within these buildings, based on a review of RLCRs and PDSRs for these buildings. In the remaining UBC buildings, only aluminum silicate (clay) was identified as being used in Buildings 778 and 887.

Six buildings identified generating aluminum waste. Two buildings (371 and 707) identified the waste to be aluminum oxide and magnesium oxide crucibles. Two buildings (778 and 887) identified the waste to be aluminum silicate (clay) combustibles associated with adhesives. Building 779 waste was identified as a desiccant aluminum oxide and Building 559 waste was identified as processing agents that may contain lithium aluminum hydride.

Aluminum was not identified above a RFCA AL requiring an accelerated action based on SAPs, SAP Addenda, or Closeout Reports for IHSSs and UBC sites.

In reviewing the aluminum soil data beneath the slabs for UBC sites (Figure 1) the summary statistics presented in Table 8 were generated.

**Table 8 UBC Soil Summary Statistics for Aluminum (mg/kg)**

| UBC | Analyte | Total Number of Samples | Detection Frequency > Background[8] | Mean | Maximum Concentration | Standard Deviation | Background Mean Plus 2SD | Unit |
|---|---|---|---|---|---|---|---|---|
| 122 | Aluminum | 6 | 33.33% | 10,550 | 19000 | 7,879 | 16,715 | mg/kg |
| 123 | Aluminum | 0 | NA | NA | NA | NA | 16,715 | mg/kg |
| 331 | Aluminum | 16 | 56.25% | 15,900 | 22000 | 3,871 | 16,715 | mg/kg |
| 371 | Aluminum | 1 | 0.00% | 2,200 | 2200 | NA | 16,715 | mg/kg |
| 374 | Aluminum | 3 | 0.00% | 4,123 | 6870 | 2,600 | 16,715 | mg/kg |
| 439 | Aluminum | 6 | 0.00% | 6,585 | 11000 | 2,967 | 16,715 | mg/kg |
| 440 | Aluminum | 10 | 20.00% | 11,610 | 20000 | 5,514 | 16,715 | mg/kg |
| 441 | Aluminum | 5 | 100.00% | 22,000 | 27000 | 3,873 | 16,715 | mg/kg |
| 442 | Aluminum | 11 | 45.45% | 17,403 | 29000 | 7,224 | 16,715 | mg/kg |
| 444 | Aluminum | 39 | 43.59% | 15,846 | 31000 | 6,037 | 16,715 | mg/kg |
| 445 | Aluminum | 1 | 100.00% | 37,000 | 37000 | NA | 16,715 | mg/kg |
| 447 | Aluminum | 17 | 88.24% | 22,818 | 38000 | 7,467 | 16,715 | mg/kg |
| 450 | Aluminum | 1 | 100.00% | 17,000 | 17000 | NA | 16,715 | mg/kg |
| 455 | Aluminum | 1 | 0.00% | 6,600 | 6600 | NA | 16,715 | mg/kg |
| 528 | Aluminum | 1 | 100.00% | 20,000 | 20000 | NA | 16,715 | mg/kg |
| 559 | Aluminum | 12 | 16.67% | 12,333 | 22000 | 5,533 | 16,715 | mg/kg |
| 701 | Aluminum | 4 | 50.00% | 15,200 | 24000 | 6,814 | 16,715 | mg/kg |
| 707 | Aluminum | 20 | 0.00% | 5,390 | 13000 | 2,406 | 16,715 | mg/kg |
| 712/713 | Aluminum | 12 | 50.00% | 18,558 | 44000 | 12,452 | 16,715 | mg/kg |
| 770 | Aluminum | 2 | 50.00% | 16,500 | 18000 | 2,121 | 16,715 | mg/kg |
| 771 | Aluminum | 12 | 8.33% | 13,131 | 21000 | 3,704 | 16,715 | mg/kg |
| 774 | Aluminum | 4 | 100.00% | 18,750 | 21000 | 1,500 | 16,715 | mg/kg |
| 776 | Aluminum | 20 | 35.00% | 13,875 | 33000 | 8,745 | 16,715 | mg/kg |
| 777 | Aluminum | 25 | 8.00% | 10,504 | 35000 | 7,334 | 16,715 | mg/kg |
| 778 | Aluminum | 15 | 13.33% | 11,040 | 21000 | 5,778 | 16,715 | mg/kg |
| 779 | Aluminum | 3 | 100.00% | 29,667 | 32000 | 2,082 | 16,715 | mg/kg |
| 865 | Aluminum | 25 | 28.00% | 13,308 | 36000 | 8,184 | 16,715 | mg/kg |
| 881 | Aluminum | 25 | 28.00% | 15,800 | 23000 | 3,765 | 16,715 | mg/kg |
| 883 | Aluminum | 12 | 16.67% | 12,908 | 22000 | 4,397 | 16,715 | mg/kg |
| 886 | Aluminum | 23 | 21.74% | 12,684 | 59000 | 11,910 | 16,715 | mg/kg |
| 889 | Aluminum | 3 | 0.00% | 14,433 | 16300 | 1,665 | 16,715 | mg/kg |
| 991 | Aluminum | 10 | 60.00% | 16,040 | 37000 | 10,597 | 16,715 | mg/kg |

NA = Not Applicable

[8] This column indicates those samples that were detected and greater than background. As a result, if this field shows 0% and a mean and maximum concentration are reported, the values represent those analytes detected but less than background.

### 2.1.2 Antimony

Antimony was not identified or discussed in building process information (CDH 1992; DOE 2004). Antimony has not been found associated with UBC sites (DOE 2004).

Antimony was initially identified in the ChemRisk Task 1 Report as a chemical in inventory at RFETS (although no specific building was identified). Examples include antimony in 20% hydrochloric acid (HCl) solution, antimony iodide, antimony oxide, antimony pentachloride, antimony powder, antimony trioxide, and antimony trichloride. These chemicals appeared to have been used as laboratory standards or analytical testing materials because they were used in very small quantities. This is confirmed based on a review of waste generated within process buildings, where antimony was identified to be present within only one RFETS building (559), which was a laboratory building (Table 4). Antimony was not carried forward as a material of concern for the ChemRisk process indicating an insufficient quantity existed at RFETS to pose a potential off-site health hazard (CDH 1991a, 1991b).

Building 559 is the only building identifying waste containing antimony and as an underlying hazardous constituent.

At the bermed area east of the North Target Area at the East Firing Range, one sample out of thirty (CW37-012) identified antimony at a concentration (433 mg/kg) greater than the RFCA AL (409 mg/kg) (DOE 2005b). This surface soil was removed (DOE 2005). Antimony was not identified at other areas of the site above a RFCA AL requiring an accelerated action based on SAPs, SAP Addenda, or Closeout Reports for IHSSs and UBCs.

In reviewing the antimony soil data beneath the slabs for UBC sites (Figure 2), the summary statistics presented in Table 9 were generated.

**Table 9 UBC Soil Summary Statistics for Antimony (mg/kg)**

| UBC | Analyte | Total Number of Samples | Detection Frequency > Background[9] | Mean | Maximum Concentration | Standard Deviation | Background Mean Plus 2SD | Unit |
|---|---|---|---|---|---|---|---|---|
| 122 | Antimony | 6 | 0.00% | 0.167 | 0.3 | 0.065 | 0.436 | mg/kg |
| 123 | Antimony | 0 | NA | NA | NA | NA | 0.436 | mg/kg |
| 331 | Antimony | 16 | 31.25% | 0.382 | 0.77 | 0.219 | 0.436 | mg/kg |
| 371 | Antimony | 1 | 0.00% | ND | ND | ND | 0.436 | mg/kg |
| 374 | Antimony | 3 | 0.00% | ND | ND | ND | 0.436 | mg/kg |
| 439 | Antimony | 6 | 0.00% | ND | ND | ND | 0.436 | mg/kg |
| 440 | Antimony | 10 | 30.00% | 0.361 | 1.4 | 0.420 | 0.436 | mg/kg |
| 441 | Antimony | 5 | 0.00% | ND | ND | ND | 0.436 | mg/kg |
| 442 | Antimony | 11 | 9.09% | 0.257 | 0.58 | 0.107 | 0.436 | mg/kg |
| 444 | Antimony | 39 | 7.69% | 0.192 | 0.57 | 0.112 | 0.436 | mg/kg |
| 445 | Antimony | 1 | 0.00% | ND | ND | ND | 0.436 | mg/kg |
| 447 | Antimony | 17 | 17.65% | 0.280 | 0.46 | 0.132 | 0.436 | mg/kg |
| 450 | Antimony | 1 | 0.00% | ND | ND | ND | 0.436 | mg/kg |
| 455 | Antimony | 1 | 0.00% | ND | ND | ND | 0.436 | mg/kg |

[9] This column indicates those samples that were detected and greater than background. As a result, if this field shows 0% and a mean and maximum concentration are reported, the values represent those analytes detected but less than background.

| UBC | Analyte | Total Number of Samples | Detection Frequency > Background[9] | Mean | Maximum Concentration | Standard Deviation | Background Mean Plus 2SD | Unit |
|---|---|---|---|---|---|---|---|---|
| 528 | Antimony | 1 | 0.00% | ND | ND | ND | 0.436 | mg/kg |
| 559 | Antimony | 12 | 25.00% | 0.279 | 0.58 | 0.184 | 0.436 | mg/kg |
| 701 | Antimony | 4 | 0.00% | ND | ND | ND | 0.436 | mg/kg |
| 707 | Antimony | 20 | 0.00% | 0.163 | 0.43 | 0.072 | 0.436 | mg/kg |
| 712/713 | Antimony | 12 | 33.33% | 0.934 | 4 | 1.26 | 0.436 | mg/kg |
| 770 | Antimony | 2 | 0.00% | ND | ND | ND | 0.436 | mg/kg |
| 771 | Antimony | 12 | 0.00% | ND | ND | ND | 0.436 | mg/kg |
| 774 | Antimony | 4 | 0.00% | ND | ND | ND | 0.436 | mg/kg |
| 776 | Antimony | 20 | 5.00% | 0.167 | 0.44 | 0.076 | 0.436 | mg/kg |
| 777 | Antimony | 25 | 0.00% | 0.158 | 0.3 | 0.051 | 0.436 | mg/kg |
| 778 | Antimony | 15 | 13.33% | 0.281 | 1.1 | 0.308 | 0.436 | mg/kg |
| 779 | Antimony | 3 | 0.00% | 0.213 | 0.33 | 0.101 | 0.436 | mg/kg |
| 865 | Antimony | 25 | 0.00% | 0.153 | 0.38 | 0.049 | 0.436 | mg/kg |
| 881 | Antimony | 25 | 24.00% | 0.307 | 0.6 | 0.139 | 0.436 | mg/kg |
| 883 | Antimony | 12 | 25.00% | 0.354 | 1.2 | 0.300 | 0.436 | mg/kg |
| 886 | Antimony | 22 | 9.09% | 0.202 | 0.59 | 0.128 | 0.436 | mg/kg |
| 889 | Antimony | 3 | 0.00% | ND | ND | ND | 0.436 | mg/kg |
| 991 | Antimony | 10 | 0.00% | 0.172 | 0.36 | 0.067 | 0.436 | mg/kg |

NA = Not Applicable ND = Not Detected

### 2.1.3 Arsenic

Arsenic was not identified or discussed in building process information (CDH 1992; DOE 2004). Arsenic has not been found associated with UBC sites (DOE 2004).

Arsenic was initially identified in the ChemRisk Task 1 Report as a chemical in inventory at RFETS (although no specific building was identified) as well as a likely organic-arsenical compound found in pesticides used at RFETS. Examples include arsenic acid, arsenic iodide, arsenic metals, arsenic pentoxide, arsenic solution 3103, arsenic trioxide, arsenious oxide, and arsenious acid (CDH 1991a). These chemicals were identified to be present at RFETS in very small quantities (less than 1 kilogram [kg]), and were identified as laboratory standards used in Buildings 444, 559, 779, and 881. The Task 2 report concluded that based on the limited use of these chemicals and their annual usage rates, which were greater than inventory quantities, their release to the environment was estimated to be minimal or there would be no release (CDH 1991b).

Arsenic waste has been generated from both laboratory and process buildings (Table 4), and at Building 778 (Plant Laundry Facility), Building 887 (managed process and sanitary waste), and Building 889 (Decontamination and Waste Reduction Facility) (Table 7).

There is no record of spills involving arsenic within these buildings, based on a review of RLCRs, PDSRs and Closeout Reports for these buildings.

Arsenic was identified as present in soil above the RFCA AL requiring an accelerated action based on SAPs, SAP Addenda, or Closeout Reports for IHSSs and UBC sites. Specifically, at the Building 712/713 cooling towers (IHSS 700-137), in which arsenic may have been a component of the rust inhibitors used in the cooling towers, and at the East Firing Range (IHSS SE-1602) as a component in lead shot. In addition to these two areas, arsenic was also identified to be present at each of the downspouts to Building 707 (IHSS Group 700-2) (at concentrations above the RFCA AL), which may have been associated with rat poison used on the roof or the presence of treated lumber also located on the roof.

In reviewing the arsenic soil data beneath the slabs for UBC sites (Figure 3), the summary statistics presented in Table 10 were generated.

**Table 10 UBC Soil Summary Statistics for Arsenic (mg/kg)**

| UBC | Analyte | Total Number of Samples | Detection Frequency > Background[10] | Mean | Maximum Concentration | Standard Deviation | Background Mean Plus 2SD | Unit |
|---|---|---|---|---|---|---|---|---|
| 122 | Arsenic | 6 | 0.00% | 4.42 | 9.1 | 3.50 | 10.1 | mg/kg |
| 123 | Arsenic | 0 | NA | NA | NA | NA | 10.1 | mg/kg |
| 331 | Arsenic | 16 | 0.00% | 5.48 | 8.7 | 1.72 | 10.1 | mg/kg |
| 371 | Arsenic | 1 | 0.00% | 1.20 | 1.2 | NA | 10.1 | mg/kg |
| 374 | Arsenic | 3 | 0.00% | 1.09 | 1.3 | 0.287 | 10.1 | mg/kg |
| 439 | Arsenic | 6 | 0.00% | 2.05 | 4 | 1.03 | 10.1 | mg/kg |
| 440 | Arsenic | 10 | 10.00% | 5.60 | 12 | 3.50 | 10.1 | mg/kg |
| 441 | Arsenic | 5 | 20.00% | 7.58 | 11 | 2.23 | 10.1 | mg/kg |
| 442 | Arsenic | 11 | 0.00% | 5.37 | 8.7 | 1.79 | 10.1 | mg/kg |
| 444 | Arsenic | 39 | 0.00% | 4.86 | 8.4 | 1.72 | 10.1 | mg/kg |
| 445 | Arsenic | 1 | 0.00% | 8.20 | 8.2 | NA | 10.1 | mg/kg |
| 447 | Arsenic | 17 | 0.00% | 6.16 | 8.8 | 1.69 | 10.1 | mg/kg |
| 450 | Arsenic | 1 | 0.00% | 6.30 | 6.3 | NA | 10.1 | mg/kg |
| 455 | Arsenic | 1 | 0.00% | 1.70 | 1.7 | NA | 10.1 | mg/kg |
| 528 | Arsenic | 1 | 0.00% | ND | ND | ND | 10.1 | mg/kg |
| 559 | Arsenic | 12 | 0.00% | 4.67 | 8.5 | 1.94 | 10.1 | mg/kg |
| 701 | Arsenic | 4 | 0.00% | 3.83 | 5.5 | 1.66 | 10.1 | mg/kg |
| 707 | Arsenic | 20 | 0.00% | 1.49 | 3.3 | 0.614 | 10.1 | mg/kg |
| 712/713 | Arsenic | 12 | 33.33% | 7.78 | 15 | 4.47 | 10.1 | mg/kg |
| 770 | Arsenic | 2 | 0.00% | 5.80 | 6.1 | 0.424 | 10.1 | mg/kg |
| 771 | Arsenic | 12 | 25.00% | 10.2 | 31.8 | 7.57 | 10.1 | mg/kg |
| 774 | Arsenic | 4 | 0.00% | 5.53 | 8.2 | 2.16 | 10.1 | mg/kg |
| 776 | Arsenic | 20 | 0.00% | 4.13 | 9 | 2.46 | 10.1 | mg/kg |
| 777 | Arsenic | 25 | 4.00% | 3.47 | 11 | 2.37 | 10.1 | mg/kg |
| 778 | Arsenic | 15 | 0.00% | 4.33 | 10 | 2.31 | 10.1 | mg/kg |
| 779 | Arsenic | 3 | 33.33% | 7.80 | 11 | 3.67 | 10.1 | mg/kg |
| 865 | Arsenic | 25 | 0.00% | 3.16 | 6.3 | 1.43 | 10.1 | mg/kg |
| 881 | Arsenic | 25 | 0.00% | 4.83 | 7.6 | 1.03 | 10.1 | mg/kg |
| 883 | Arsenic | 12 | 0.00% | 3.64 | 8.5 | 2.53 | 10.1 | mg/kg |
| 886 | Arsenic | 23 | 4.35% | 4.20 | 12.3 | 2.36 | 10.1 | mg/kg |
| 889 | Arsenic | 3 | 0.00% | 2.67 | 3.8 | 1.03 | 10.1 | mg/kg |
| 991 | Arsenic | 10 | 10.00% | 4.12 | 12 | 3.81 | 10.1 | mg/kg |

NA = Not Applicable ND = Not Detected

[10] This column indicates those samples that were detected and greater than background. As a result, if this field shows 0% and a mean and maximum concentration are reported, the values represent those analytes detected but less than background.

### 2.1.4 Barium

Barium was not identified or discussed in building process information (CDH 1992; DOE 2004). Barium has not been found associated with UBC sites (DOE 2004).

Barium was initially identified in the ChemRisk Task 1 Report as a chemical in inventory at RFETS (although no specific building was identified) (CDH 1991a, 1991b). Several chemical compounds were identified in the Task 1 Report, which indicated small quantities were in inventory with the exception of barium chloride, which had an inventory ranging between 9 kg (in 1988) and 23 kg (in 1974). However, based on the estimated quantity of these chemicals used, barium was not carried forward as a material of concern for the ChemRisk process.

Barium waste has been generated from both laboratory and process buildings (Table 4), and from Buildings 439 (Radiological Survey), 442 (filter test facility), 778 (Plant Laundry Facility), 886 (Critical Mass Lab), and 887 (managed process and sanitary waste) (Table 7).

Barium was not identified above a RFCA AL requiring an accelerated action based on SAPs, SAP Addenda, or Closeout Reports for IHSSs and UBC sites.

In reviewing the barium soil data beneath the slabs for UBC sites (Figure 4), the summary statistics presented in Table 11 were generated. Accelerated action closeout and data summary reports have indicated barium to be associated with building concrete.

**Table 11 UBC Soil Summary Statistics for Barium (mg/kg)**

| UBC | Analyte | Total Number of Samples | Detection Frequency > Background[11] | Mean | Maximum Concentration | Standard Deviation | Background Mean Plus 2SD | Unit |
|---|---|---|---|---|---|---|---|---|
| 122 | Barium | 6 | 0.00% | 48.5 | 87 | 26.1 | 141 | mg/kg |
| 123 | Barium | 0 | NA | NA | NA | NA | 141 | mg/kg |
| 331 | Barium | 16 | 0.00% | 67.7 | 100 | 17.8 | 141 | mg/kg |
| 371 | Barium | 1 | 0.00% | 16.0 | 16 | NA | 141 | mg/kg |
| 374 | Barium | 3 | 0.00% | 25.3 | 31.8 | 9.80 | 141 | mg/kg |
| 439 | Barium | 6 | 0.00% | 52.1 | 78.5 | 14.7 | 141 | mg/kg |
| 440 | Barium | 10 | 10.00% | 90.6 | 290 | 73.8 | 141 | mg/kg |
| 441 | Barium | 5 | 0.00% | 71.8 | 82 | 6.98 | 141 | mg/kg |
| 442 | Barium | 11 | 0.00% | 78.8 | 104 | 26.8 | 141 | mg/kg |
| 444 | Barium | 39 | 7.69% | 78.0 | 200 | 35.0 | 141 | mg/kg |
| 445 | Barium | 1 | 0.00% | 81.0 | 81 | NA | 141 | mg/kg |
| 447 | Barium | 17 | 5.88% | 81.2 | 170 | 35.0 | 141 | mg/kg |
| 450 | Barium | 1 | 0.00% | 93.0 | 93 | NA | 141 | mg/kg |
| 455 | Barium | 1 | 0.00% | 52.0 | 52 | NA | 141 | mg/kg |
| 528 | Barium | 1 | 100.00% | 180 | 180 | NA | 141 | mg/kg |
| 559 | Barium | 12 | 0.00% | 67.0 | 130 | 32.5 | 141 | mg/kg |
| 701 | Barium | 4 | 0.00% | 88.0 | 120 | 23.7 | 141 | mg/kg |
| 707 | Barium | 20 | 0.00% | 45.3 | 91 | 17.4 | 141 | mg/kg |
| 712/713 | Barium | 12 | 8.33% | 101 | 180 | 37.6 | 141 | mg/kg |

[11] This column indicates those samples that were detected and greater than background. As a result, if this field shows 0% and a mean and maximum concentration are reported, the values represent those analytes detected but less than background.

| UBC | Analyte | Total Number of Samples | Detection Frequency > Background[11] | Mean | Maximum Concentration | Standard Deviation | Background Mean Plus 2SD | Unit |
|---|---|---|---|---|---|---|---|---|
| 770 | Barium | 2 | 100.00% | 175 | 200 | 35.4 | 141 | mg/kg |
| 771 | Barium | 12 | 16.67% | 98.5 | 196 | 40.3 | 141 | mg/kg |
| 774 | Barium | 4 | 50.00% | 145 | 180 | 31.1 | 141 | mg/kg |
| 776 | Barium | 20 | 0.00% | 70.8 | 93 | 17.9 | 141 | mg/kg |
| 777 | Barium | 25 | 0.00% | 72.0 | 140 | 25.1 | 141 | mg/kg |
| 778 | Barium | 15 | 0.00% | 80.8 | 130 | 27.4 | 141 | mg/kg |
| 779 | Barium | 3 | 0.00% | 81.7 | 94 | 18.0 | 141 | mg/kg |
| 865 | Barium | 25 | 12.00% | 95.6 | 250 | 49.8 | 141 | mg/kg |
| 881 | Barium | 25 | 4.00% | 73.1 | 232 | 37.1 | 141 | mg/kg |
| 883 | Barium | 12 | 16.67% | 80.4 | 250 | 68.2 | 141 | mg/kg |
| 886 | Barium | 23 | 13.04% | 92.0 | 188 | 38.3 | 141 | mg/kg |
| 889 | Barium | 3 | 0.00% | 65.1 | 82.8 | 19.4 | 141 | mg/kg |
| 991 | Barium | 10 | 0.00% | 62.6 | 90 | 14.9 | 141 | mg/kg |

NA = Not Applicable

### 2.1.5 Cadmium

Cadmium compounds used at RFETS include elemental or metallic cadmium oxide, cadmium chloride, and cadmium sulfate (CDH 1992).

Cadmium was used in pit construction (Building 707); however, the amounts were relatively minor compared to the primary materials used (plutonium, uranium, beryllium, aluminum, and stainless steel) (CDH 1992; DOE 2004). Cadmium was rolled and formed in Buildings 444, 883, and 865. Cadmium was also used as a plating material (as cadmium salt) for plutonium and uranium components (Buildings 776/777 and 881). Cadmium was also alloyed with other metals (Building 444). Cadmium salts were used as neutron absorbers for criticality safety in recovery operations that took place in equipment that was not dimensionally safe (Buildings 771 and 881). Cadmium was used for thermal neutron shielding.

Cadmium plating wastes were treated in Building 774. Dilute cadmium plating rinsing solutions went to Building 374. Prior to the use of Building 374, they were sent to the Solar Evaporation Ponds (SEPs) (CDH 1992)[12]. Process waste containing cadmium, chromium and lead were managed in Building 731 (plenum deluge and process waste pit for Building 707) and Building 528 (process waste handling building).

Cadmium was identified in a 1988/1989 Chemical Inventory list for Buildings 123, 559 and 561 as laboratory chemicals acetate, chloride, iodide, nitrate, oxide, sulfate, and metal (CDH 1992). The Health Physics Laboratory (Building 123) identified 300 grams of cadmium metal.

[12] The maximum cadmium surface soil concentration at the SEPs was 382 mg/kg, which was below both the RFCA Tier I and II ALs (1920 mg/kg) that existed at the time of the accelerated action and below the May 2003 modifications to the RFCA ALs (962 mg/kg) (DOE 2003b). The maximum cadmium subsurface soil concentration at the SEPs was 547 mg/kg, which was below both the RFCA Tier I and II ALs (1920 mg/kg) and below the May 2003 modifications to the RFCA ALs (962 mg/kg).

All of the buildings identified above involved radiological operations and included extensive HEPA filtration systems. Any particulates or fines from machining cadmium metals would have been collected on these filters prior to release from the buildings.

Cadmium was identified in the ChemRisk reports as both a chemical (for example, cadmium nitrate) and in the elemental form and as a result was evaluated as cadmium compounds (CDH 1991a). Of the 100 kg of cadmium on the 1974 inventory, 57 percent was elemental and 34 percent was cadmium oxide (CDH 1992). Of the 46 kg of cadmium on the 1988/89 inventory, 31 percent was elemental and 56 percent was oxide.

Cadmium compounds were carried forward as materials of concern for the ChemRisk reports (CDH 1992). However, the Tasks 3 & 4 report indicated that, based on the nature of their use, cadmium compounds did not warrant further quantitative evaluation of potential off-site impacts when comparing the difference between the source maps and inventory quantities. A comparison of the emission source maps with inventory quantities presented in the building summaries (Appendix B to the Tasks 3 & 4 report) indicated buildings or processes that used cadmium were not identified as emission sources. This was due to the manner in which the material was stored, processed, or handled and was not expected to lead to significant emissions. In addition, on a number of the emission source maps, the waste treatment buildings were identified as air emission sources for chemicals that were not expected to be released in significant quantities in their primary areas of use as indicated by inventory quantities.

In addition, cadmium was one of 5 metals (cadmium, chromium, lead, mercury, and nickel) included in a group of 13 chemicals that underwent extensive investigation by ChemRisk (CDH 1992). Results indicated that uses of these materials at RFETS had been extremely limited in scope or duration, associated with insignificant quantities of the material, or involved processes or forms of the materials that were not expected to have significant off-site releases. These materials, therefore, did not warrant further quantitative evaluation as potential off-site impacts in the ChemRisk process.

Spills involving process wastes (containing cadmium, chromium, and lead) did occur within certain buildings, based on a review of RLCRs and PDSRs for these buildings. Specifically, history and process knowledge for Buildings 371, 374 and 559 revealed multiple spills of acids typically containing cadmium, chromium, and lead from the recovery of plutonium. These liquids may also have contained detectable levels of RCRA volatile organics such as carbon tetrachloride and perchloroethylene. A small number of randomly located concrete floor samples were collected and analyzed for RCRA metals and volatile organic compounds (VOCs). All results indicated concentrations were below regulatory limits.

In addition, historical process knowledge for Buildings 771 and 774 indicate toxic metals were present in solutions and sludge/residues contained in process equipment, tanks, process lines, and waste containers. There were many incidents involving nitric acid solution spills that etched into the floor or walls. However, all sample results were below RCRA regulatory limits.

Cadmium waste has been generated from both laboratory and process buildings (Table 4 and Table 7).

Cadmium was not identified above a RFCA AL requiring an accelerated action based on SAPs, SAP Addenda, or the Closeout Report for IHSSs and UBC sites.

In reviewing the cadmium soil data beneath the slabs for UBC sites (Figure 5), the summary statistics presented in Table 12 were generated.

**Table 12 UBC Soil Summary Statistics for Cadmium (mg/kg)**

| UBC | Analyte | Total Number of Samples | Detection Frequency > Background[13] | Mean | Maximum Concentration | Standard Deviation | Background Mean Plus 2SD | Unit |
|---|---|---|---|---|---|---|---|---|
| 122 | Cadmium | 6 | 0.00% | ND | ND | ND | 1.62 | mg/kg |
| 123 | Cadmium | 0 | NA | NA | NA | NA | 1.62 | mg/kg |
| 331 | Cadmium | 16 | 6.25% | 0.169 | 2.2 | 0.542 | 1.62 | mg/kg |
| 371 | Cadmium | 1 | 0.00% | ND | ND | ND | 1.62 | mg/kg |
| 374 | Cadmium | 3 | 0.00% | ND | ND | ND | 1.62 | mg/kg |
| 439 | Cadmium | 6 | 0.00% | ND | ND | ND | 1.62 | mg/kg |
| 440 | Cadmium | 10 | 0.00% | 0.127 | 0.41 | 0.118 | 1.62 | mg/kg |
| 441 | Cadmium | 5 | 0.00% | ND | ND | ND | 1.62 | mg/kg |
| 442 | Cadmium | 11 | 0.00% | 0.139 | 0.4 | 0.147 | 1.62 | mg/kg |
| 444 | Cadmium | 39 | 5.13% | 0.782 | 14 | 2.89 | 1.62 | mg/kg |
| 445 | Cadmium | 1 | 0.00% | 0.160 | 0.16 | NA | 1.62 | mg/kg |
| 447 | Cadmium | 17 | 0.00% | 0.216 | 1.6 | 0.412 | 1.62 | mg/kg |
| 450 | Cadmium | 1 | 0.00% | 0.280 | 0.28 | NA | 1.62 | mg/kg |
| 455 | Cadmium | 1 | 0.00% | ND | ND | ND | 1.62 | mg/kg |
| 528 | Cadmium | 1 | 0.00% | 0.450 | 0.45 | NA | 1.62 | mg/kg |
| 559 | Cadmium | 12 | 0.00% | 0.092 | 0.23 | 0.071 | 1.62 | mg/kg |
| 701 | Cadmium | 4 | 0.00% | ND | ND | ND | 1.62 | mg/kg |
| 707 | Cadmium | 20 | 0.00% | 0.055 | 0.27 | 0.061 | 1.62 | mg/kg |
| 712/713 | Cadmium | 12 | 8.33% | 0.660 | 3.9 | 1.11 | 1.62 | mg/kg |
| 770 | Cadmium | 2 | 0.00% | 0.308 | 0.58 | 0.384 | 1.62 | mg/kg |
| 771 | Cadmium | 12 | 8.33% | 0.424 | 2.3 | 0.642 | 1.62 | mg/kg |
| 774 | Cadmium | 4 | 0.00% | 0.051 | 0.093 | 0.028 | 1.62 | mg/kg |
| 776 | Cadmium | 20 | 0.00% | 0.053 | 0.43 | 0.089 | 1.62 | mg/kg |
| 777 | Cadmium | 25 | 0.00% | 0.095 | 1.1 | 0.229 | 1.62 | mg/kg |
| 778 | Cadmium | 15 | 0.00% | ND | ND | ND | 1.62 | mg/kg |
| 779 | Cadmium | 3 | 0.00% | 0.062 | 0.08 | 0.024 | 1.62 | mg/kg |
| 865 | Cadmium | 25 | 0.00% | 0.045 | 0.17 | 0.034 | 1.62 | mg/kg |
| 881 | Cadmium | 25 | 0.00% | 0.076 | 0.33 | 0.075 | 1.62 | mg/kg |
| 883 | Cadmium | 12 | 0.00% | 0.224 | 1.6 | 0.456 | 1.62 | mg/kg |
| 886 | Cadmium | 23 | 0.00% | 0.123 | 0.38 | 0.103 | 1.62 | mg/kg |
| 889 | Cadmium | 3 | 0.00% | 0.075 | 0.11 | 0.045 | 1.62 | mg/kg |
| 991 | Cadmium | 10 | 0.00% | 0.117 | 0.86 | 0.261 | 1.62 | mg/kg |

NA = Not Applicable     ND = Not Detected

[13] This column indicates those samples that were detected and greater than background. As a result, if this field shows 0% and a mean and maximum concentration are reported, the values represent those analytes detected but less than background.

### 2.1.6 Chromium

Chromium compounds were used for plating in the Building 444 Research and Development (R&D) plating lab (CDH 1992; DOE 2004). Some solutions were made by mixing chromium salts with acids; others were purchased in aqueous forms. Chromium was present in anion exchange resins in Building 371. Chromium trioxide was used in Building 444 (with sulfuric and phosphoric acids) to chemically mill beryllium. Prior to 1976, chromates were added to the water as a rust inhibitor used in the Building 712/713 Cooling Towers.

Before RCRA, plating wastes were treated in Building 774 (CDH 1992). Dilute rinsates were sent to Building 374. Prior to Building 374, the Solar Evaporation Ponds were used to treat wastewater[14]. Process waste containing cadmium, chromium and lead were managed in Building 731 (plenum deluge and process waste pit for Building 707) and Building 528 (process waste handling building).

Chromium was identified in a 1988/1989 Chemical Inventory list for Buildings 123, 559 and 561 in various chemical forms such as chloride, nitrate, oxide, potassium sulfate, sulfate, and trioxide (CDH 1992).

Chromium compounds were carried forward as materials of concern for the ChemRisk reports (CDH 1992). However, the Tasks 3 & 4 report indicated that, based on the nature of their use, they did not warrant further quantitative evaluation of potential off-site impacts. A comparison of the emission source maps with inventory quantities presented in the building summaries (Appendix B to the Tasks 3 & 4 report) indicated buildings or processes that used chromium were not identified as emission sources. This was due to the manner in which the material was stored, processed, or handled, and was not expected to lead to significant emissions.

In addition, chromium was one of 5 metals (cadmium, chromium, lead, mercury, and nickel) included in a group of 13 chemicals that underwent extensive investigation by ChemRisk (CDH 1992). Results indicated that uses of these materials at RFETS had been extremely limited in scope or duration, associated with insignificant quantities of the material, or involved processes or forms of the materials that were not expected to have significant off-site releases. These materials, therefore, did not warrant further quantitative evaluation as potential off-site impacts in the ChemRisk process.

Spills involving process wastes (containing cadmium, chromium, and lead) did occur within certain buildings, based on a review of RLCRs and PDSRs for these buildings. Specifically, history and process knowledge for Buildings 371, 374, and 559 revealed multiple spills of acids typically containing cadmium, chromium, and lead from the recovery of plutonium. These liquids may also have contained detectable levels of RCRA volatile organics such as carbon tetrachloride and perchloroethylene. A small number of randomly located concrete floor samples were collected and analyzed for RCRA metals and VOCs. All results indicated concentrations were below regulatory limits.

[14] The maximum chromium surface soil concentration at the SEPs was 120 mg/kg and the maximum subsurface soil concentration was 56.9 mg/kg (DOE 2003b). These concentrations are below both the RFCA Tier I (4.41E+05 mg/kg) and Tier II (4410 mg/kg) ALs (surface and subsurface soil) for chromium VI that existed at the time of the accelerated action. These concentrations were also below the May 2003 modifications to the RFCA ALs (268 mg/kg) for chromium VI.

In addition, historical process knowledge for Buildings 771 and 774 indicate toxic metals were present in solutions and sludge/residues contained in process equipment, tanks, process lines, and waste containers. There were many incidents involving nitric acid solution spills that etched into the floor or walls. However, all sample results were below RCRA regulatory limits.

Chromium waste has been generated from both laboratory and process buildings (Table 4 and Table 7).

Chromium was identified as present in soil above the RFCA AL requiring an accelerated action based on SAPs, SAP Addenda, or the Closeout Report for IHSS 500-158, near Building 551. (This may have been related to scrap metal storage in the area.) Immediately north of Building 551, one surface soil sampling location (CA41-025) indicated a chromium concentration (2,600 mg/kg) greater than the RFCA WRW AL of 268 mg/kg (DOE 2004c). This location was removed and all remaining concentrations were below RFCA WRW ALs (DOE 2004c).

In 1989, a chromic acid spill from the basement of Building 444 passed through the sanitary waste treatment system and reached an on-site retention pond (B-3). The solution leaked through cracks in the floor into the building foundation drain system. It was collected in a sump and pumped into the Plant's sanitary sewer system. The water was discharged to retention Pond B-3. This water was then pumped to the spray fields (IHSSs 216.2 and 216.3). Because the ponds and the surfaces of the spray fields were frozen, significant amounts of chromic acid-contaminated spray water ran off the hillsides adjacent to the spray fields. This water was collected in Ponds B-3, B-4, and B-5 on Plant site. Water from Pond B-5 was pumped into Upper Church Ditch; concentrations in this water were below the surface water standard of 0.05 part per million (ppm) (CDH 1992).

In reviewing the chromium soil data beneath the slabs for UBC sites (Figure 6), the summary statistics presented in Table 13 were generated.

**Table 13 UBC Soil Summary Statistics for Chromium (mg/kg)**

| UBC | Analyte | Total Number of Samples | Detection Frequency > Background[15] | Mean | Maximum Concentration | Standard Deviation | Background Mean Plus 2SD | Unit |
|---|---|---|---|---|---|---|---|---|
| 122 | Chromium (total) | 6 | 16.67% | 12.2 | 17 | 4.89 | 16.8 | mg/kg |
| 123 | Chromium (total) | 0 | NA | NA | NA | NA | 16.8 | mg/kg |
| 331 | Chromium (total) | 16 | 56.25% | 24.5 | 68 | 15.4 | 16.8 | mg/kg |
| 371 | Chromium (total) | 1 | 0.00% | 6.50 | 6.5 | NA | 16.8 | mg/kg |
| 374 | Chromium (total) | 3 | 0.00% | 8.70 | 11.8 | 3.10 | 16.8 | mg/kg |
| 439 | Chromium (total) | 6 | 0.00% | 10.4 | 14.8 | 3.47 | 16.8 | mg/kg |
| 440 | Chromium (total) | 10 | 60.00% | 18.9 | 37 | 8.52 | 16.8 | mg/kg |
| 441 | Chromium (total) | 5 | 60.00% | 19.4 | 30 | 6.19 | 16.8 | mg/kg |
| 442 | Chromium (total) | 11 | 45.45% | 15.9 | 20.7 | 3.73 | 16.8 | mg/kg |
| 444 | Chromium (total) | 39 | 41.03% | 18.0 | 79 | 11.6 | 16.8 | mg/kg |
| 445 | Chromium (total) | 1 | 100.00% | 27.0 | 27 | NA | 16.8 | mg/kg |
| 447 | Chromium (total) | 17 | 88.24% | 19.3 | 27 | 4.29 | 16.8 | mg/kg |
| 450 | Chromium (total) | 1 | 0.00% | 14.0 | 14 | NA | 16.8 | mg/kg |

[15] This column indicates those samples that were detected and greater than background. As a result, if this field shows 0% and a mean and maximum concentration are reported, the values represent those analytes detected but less than background.

| UBC | Analyte | Total Number of Samples | Detection Frequency > Background[15] | Mean | Maximum Concentration | Standard Deviation | Background Mean Plus 2SD | Unit |
|---|---|---|---|---|---|---|---|---|
| 455 | Chromium (total) | 1 | 0.00% | 11.0 | 11 | NA | 16.8 | mg/kg |
| 528 | Chromium (total) | 1 | 100.00% | 23.0 | 23 | NA | 16.8 | mg/kg |
| 559 | Chromium (total) | 12 | 25.00% | 12.7 | 26 | 5.30 | 16.8 | mg/kg |
| 701 | Chromium (total) | 4 | 75.00% | 17.5 | 21 | 2.89 | 16.8 | mg/kg |
| 707 | Chromium (total) | 20 | 0.00% | 9.61 | 15 | 2.18 | 16.8 | mg/kg |
| 712/713 | Chromium (total) | 12 | 66.67% | 32.3 | 100 | 28.3 | 16.8 | mg/kg |
| 770 | Chromium (total) | 2 | 50.00% | 22.0 | 29 | 9.90 | 16.8 | mg/kg |
| 771 | Chromium (total) | 12 | 25.00% | 17.7 | 58 | 13.0 | 16.8 | mg/kg |
| 774 | Chromium (total) | 4 | 75.00% | 17.8 | 19 | 1.50 | 16.8 | mg/kg |
| 776 | Chromium (total) | 20 | 60.00% | 19.8 | 34 | 7.57 | 16.8 | mg/kg |
| 777 | Chromium (total) | 25 | 56.00% | 29.3 | 160 | 36.0 | 16.8 | mg/kg |
| 778 | Chromium (total) | 15 | 33.33% | 16.5 | 32 | 8.01 | 16.8 | mg/kg |
| 779 | Chromium (total) | 3 | 100.00% | 20.0 | 21 | 1.73 | 16.8 | mg/kg |
| 865 | Chromium (total) | 25 | 28.00% | 15.1 | 36 | 6.66 | 16.8 | mg/kg |
| 881 | Chromium (total) | 25 | 32.00% | 18.9 | 111 | 19.5 | 16.8 | mg/kg |
| 883 | Chromium (total) | 12 | 41.67% | 16.8 | 31 | 5.86 | 16.8 | mg/kg |
| 886 | Chromium (total) | 23 | 30.43% | 15.0 | 35.2 | 7.76 | 16.8 | mg/kg |
| 889 | Chromium (total) | 3 | 66.67% | 16.3 | 20.1 | 4.14 | 16.8 | mg/kg |
| 991 | Chromium (total) | 10 | 50.00% | 16.2 | 32 | 7.75 | 16.8 | mg/kg |

NA = Not Applicable

### 2.1.7 Cobalt

Cobalt was not identified or discussed in building process information (CDH 1992; DOE 2004). Cobalt has not been found associated with UBC sites (DOE 2004).

Cobalt was initially identified in the ChemRisk Task 1 report as a chemical in inventory at RFETS (although no specific building was identified) (CDH 1991a). A majority of these chemicals appeared to have been used as laboratory standards or analytical testing materials because they were used in very small quantities. However, one compound, cobalt oxide was identified as present in the 1974 inventory at 677 kg and then later in 1988 in less than 1 kg.

In the ChemRisk Task 2 report (stage 2 screening) a derived reference dose (RfD) was calculated for cobalt by dividing its lethal dose ($LD_{50}$[16]) by a factor of 100,000 (CDH 1991b). This approach was considered very conservative for essential nutrients like cobalt. The human daily dietary intake of cobalt was estimated to be approximately 0.1 to 0.25 milligram per day (mg/day) (based on a 1963 California State Water Resources Control Board concentration [CDH 1991b]). Using the exposure scenarios described, concentrations of cobalt in air and water were calculated. The average daily doses of cobalt received by a maximally exposed individual through inhalation and drinking water ingestion were 0.029 mg/day and 0.085 mg/day, respectively. These doses were lower than the daily dietary intake level and were unlikely to pose a health hazard to off-site individuals. For this reason, cobalt was not carried forward as a material of concern for the

[16] $LD_{50}$ is the amount of material, given all at once, which causes the death of 50 percent (one half) of a group of test animals. $LD_{50}$ is one way of measuring the acute toxicity of a material.

ChemRisk process. Note that cobalt oxide was identified in the various tables during the stage 2 screening.

There is no record of spills involving cobalt within these buildings, based on a review of RLCRs and PDSRs for these buildings. There is no record of cobalt waste being generated at RFETS (Table 4 and Table 7).

Cobalt was not identified above a RFCA AL requiring an accelerated action based on SAPs, SAP Addenda, or Closeout Reports for IHSSs and UBC sites.

In reviewing the cobalt soil data beneath the slabs for UBC sites (Figure 7), the summary statistics presented in Table 14 were generated.

**Table 14 UBC Soil Summary Statistics for Cobalt (mg/kg)**

| UBC | Analyte | Total Number of Samples | Detection Frequency > Background[17] | Mean | Maximum Concentration | Standard Deviation | Background Mean Plus 2SD | Unit |
|---|---|---|---|---|---|---|---|---|
| 122 | Cobalt | 6 | 0.00% | 3.28 | 5.3 | 1.41 | 10.9 | mg/kg |
| 123 | Cobalt | 0 | NA | NA | NA | NA | 10.9 | mg/kg |
| 331 | Cobalt | 16 | 6.25% | 6.64 | 22 | 4.45 | 10.9 | mg/kg |
| 371 | Cobalt | 1 | 0.00% | 1.40 | 1.4 | NA | 10.9 | mg/kg |
| 374 | Cobalt | 3 | 33.33% | 8.23 | 21.1 | 11.2 | 10.9 | mg/kg |
| 439 | Cobalt | 6 | 0.00% | 4.95 | 9 | 2.18 | 10.9 | mg/kg |
| 440 | Cobalt | 10 | 40.00% | 14.7 | 47 | 13.5 | 10.9 | mg/kg |
| 441 | Cobalt | 5 | 0.00% | 5.64 | 8.1 | 1.50 | 10.9 | mg/kg |
| 442 | Cobalt | 11 | 9.09% | 6.00 | 12.9 | 3.04 | 10.9 | mg/kg |
| 444 | Cobalt | 39 | 25.64% | 11.1 | 61 | 12.0 | 10.9 | mg/kg |
| 445 | Cobalt | 1 | 0.00% | 9.10 | 9.1 | NA | 10.9 | mg/kg |
| 447 | Cobalt | 17 | 23.53% | 9.85 | 34 | 7.21 | 10.9 | mg/kg |
| 450 | Cobalt | 1 | 100.00% | 12.0 | 12 | NA | 10.9 | mg/kg |
| 455 | Cobalt | 1 | 0.00% | 5.40 | 5.4 | NA | 10.9 | mg/kg |
| 528 | Cobalt | 1 | 0.00% | 2.50 | 2.5 | NA | 10.9 | mg/kg |
| 559 | Cobalt | 12 | 33.33% | 9.98 | 26 | 8.09 | 10.9 | mg/kg |
| 701 | Cobalt | 4 | 0.00% | 6.93 | 9.4 | 1.82 | 10.9 | mg/kg |
| 707 | Cobalt | 20 | 15.00% | 8.31 | 36 | 9.19 | 10.9 | mg/kg |
| 712/713 | Cobalt | 12 | 16.67% | 8.88 | 34 | 8.58 | 10.9 | mg/kg |
| 770 | Cobalt | 2 | 0.00% | 7.05 | 8.4 | 1.91 | 10.9 | mg/kg |
| 771 | Cobalt | 12 | 8.33% | 9.34 | 27.7 | 6.13 | 10.9 | mg/kg |
| 774 | Cobalt | 4 | 0.00% | 6.90 | 8.4 | 2.30 | 10.9 | mg/kg |
| 776 | Cobalt | 20 | 60.00% | 13.2 | 32 | 6.93 | 10.9 | mg/kg |
| 777 | Cobalt | 25 | 44.00% | 12.1 | 34 | 7.86 | 10.9 | mg/kg |
| 778 | Cobalt | 15 | 40.00% | 14.3 | 55 | 14.8 | 10.9 | mg/kg |
| 779 | Cobalt | 3 | 66.67% | 8.30 | 11 | 4.68 | 10.9 | mg/kg |
| 865 | Cobalt | 25 | 0.00% | 5.63 | 9.6 | 1.45 | 10.9 | mg/kg |
| 881 | Cobalt | 25 | 48.00% | 18.3 | 137 | 28.6 | 10.9 | mg/kg |
| 883 | Cobalt | 12 | 50.00% | 10.1 | 17 | 3.99 | 10.9 | mg/kg |
| 886 | Cobalt | 23 | 4.35% | 4.75 | 14 | 2.36 | 10.9 | mg/kg |

[17] This column indicates those samples that were detected and greater than background. As a result, if this field shows 0% and a mean and maximum concentration are reported, the values represent those analytes detected but less than background.

| UBC | Analyte | Total Number of Samples | Detection Frequency > Background[17] | Mean | Maximum Concentration | Standard Deviation | Background Mean Plus 2SD | Unit |
|---|---|---|---|---|---|---|---|---|
| 889 | Cobalt | 3 | 33.33% | 8.90 | 11.4 | 2.98 | 10.9 | mg/kg |
| 991 | Cobalt | 10 | 60.00% | 12.2 | 28 | 6.97 | 10.9 | mg/kg |

NA = Not Applicable

### 2.1.8 Copper

Copper was primarily used in metallurgical operations involved in the development of alloys within Buildings 865, 881, and 883 (CDH 1992; DOE 2004).All of these buildings involved radiological operations and included extensive HEPA filtration systems. Any particulates or fines from machining copper metals would have been collected on these filters prior to release from the buildings.

Copper was identified in the ChemRisk Task 1 report as either copper cyanide or copper sulfate and not as the metal (CDH 1991a). Copper was not carried forward as a material of concern for the ChemRisk process indicating an insufficient quantity existed at RFETS to pose a potential off-site health hazard (CDH 1991b).

Copper waste was generated from Building 559 (acid containing copper) and 881 (copper cyanide) (Table 4 and Table 7).

Copper was not identified above a RFCA AL requiring an accelerated action based on Closeout Reports for IHSSs and UBC sites. However, an elevated concentration of copper greater than the RFCA action level was identified at the East Firing Range and was removed. Soil removal at the East Firing Range was based on the presence of lead and not copper.

In reviewing the copper soil data beneath the slabs for UBC sites (Figure 8), the summary statistics presented in Table 15 were generated.

**Table 15 UBC Soil Summary Statistics for Copper (mg/kg)**

| UBC | Analyte | Total Number of Samples | Detection Frequency > Background[18] | Mean | Maximum Concentration | Standard Deviation | Background Mean Plus 2SD | Unit |
|---|---|---|---|---|---|---|---|---|
| 122 | Copper | 6 | 0.00% | 9.68 | 14 | 2.97 | 18.1 | mg/kg |
| 123 | Copper | 0 | NA | NA | NA | NA | 18.1 | mg/kg |
| 331 | Copper | 16 | 37.50% | 22.6 | 75 | 17.5 | 18.1 | mg/kg |
| 371 | Copper | 1 | 0.00% | 4.30 | 4.3 | NA | 18.1 | mg/kg |
| 374 | Copper | 3 | 33.33% | 31.5 | 84.1 | 45.6 | 18.1 | mg/kg |
| 439 | Copper | 6 | 33.33% | 16.4 | 30.4 | 7.88 | 18.1 | mg/kg |
| 440 | Copper | 10 | 70.00% | 40.5 | 120 | 33.8 | 18.1 | mg/kg |
| 441 | Copper | 5 | 0.00% | 10.4 | 13 | 1.65 | 18.1 | mg/kg |
| 442 | Copper | 11 | 0.00% | 10.7 | 16.7 | 3.99 | 18.1 | mg/kg |
| 444 | Copper | 39 | 48.72% | 31.0 | 190 | 36.8 | 18.1 | mg/kg |

[18] This column indicates those samples that were detected and greater than background. As a result, if this field shows 0% and a mean and maximum concentration are reported, the values represent those analytes detected but less than background.

| UBC | Analyte | Total Number of Samples | Detection Frequency > Background[18] | Mean | Maximum Concentration | Standard Deviation | Background Mean Plus 2SD | Unit |
|---|---|---|---|---|---|---|---|---|
| 445 | Copper | 1 | 0.00% | 12.0 | 12 | NA | 18.1 | mg/kg |
| 447 | Copper | 17 | 52.94% | 22.7 | 80 | 16.9 | 18.1 | mg/kg |
| 450 | Copper | 1 | 100.00% | 25.0 | 25 | NA | 18.1 | mg/kg |
| 455 | Copper | 1 | 100.00% | 41.0 | 41 | NA | 18.1 | mg/kg |
| 528 | Copper | 1 | 100.00% | 60.0 | 60 | NA | 18.1 | mg/kg |
| 559 | Copper | 12 | 33.33% | 24.2 | 67 | 21.3 | 18.1 | mg/kg |
| 701 | Copper | 4 | 75.00% | 32.8 | 68 | 24.5 | 18.1 | mg/kg |
| 707 | Copper | 20 | 25.00% | 20.8 | 90 | 22.4 | 18.1 | mg/kg |
| 712/713 | Copper | 12 | 91.67% | 105 | 430 | 137 | 18.1 | mg/kg |
| 770 | Copper | 2 | 0.00% | 14.5 | 18 | 4.95 | 18.1 | mg/kg |
| 771 | Copper | 12 | 66.67% | 79.6 | 421 | 135 | 18.1 | mg/kg |
| 774 | Copper | 4 | 25.00% | 16.0 | 21 | 3.56 | 18.1 | mg/kg |
| 776 | Copper | 20 | 75.00% | 35.1 | 92 | 21.9 | 18.1 | mg/kg |
| 777 | Copper | 25 | 68.00% | 31.5 | 93 | 22.7 | 18.1 | mg/kg |
| 778 | Copper | 15 | 46.67% | 34.5 | 140 | 37.2 | 18.1 | mg/kg |
| 779 | Copper | 3 | 0.00% | 7.60 | 9.8 | 2.31 | 18.1 | mg/kg |
| 865 | Copper | 25 | 8.00% | 13.1 | 26 | 4.69 | 18.1 | mg/kg |
| 881 | Copper | 25 | 0.00% | 13.3 | 17.9 | 2.79 | 18.1 | mg/kg |
| 883 | Copper | 12 | 83.33% | 58.8 | 180 | 47.5 | 18.1 | mg/kg |
| 886 | Copper | 23 | 52.17% | 144 | 1190 | 265 | 18.1 | mg/kg |
| 889 | Copper | 3 | 66.67% | 47.5 | 73 | 28.2 | 18.1 | mg/kg |
| 991 | Copper | 10 | 70.00% | 42.1 | 82 | 28.5 | 18.1 | mg/kg |

NA = Not Applicable

### 2.1.9 Iron

Processes involved in Buildings 444, 445, 450, and 455 included cleaning graphite crucibles, which were used for depleted uranium and beryllium metallurgy (CDH 1992). The removed residues contained trace amounts of iron and other cast metals. Uranium machining (Building 444) used parts fabricated from depleted uranium that contained trace amounts of iron, silica, titanium, aluminum, and stainless steel. Iron was associated with anion exchange resins in Building 371.

All of the buildings identified above involved radiological operations and included extensive HEPA filtration systems. Any particulates or fines from machining iron metals would have been collected on these filters prior to release from the buildings.

Cast iron was also the material used in pipe construction for various process waste lines within the former IA.

Iron as a metal was not identified in the ChemRisk Task 1 report as a material in inventory at RFETS (CDH 1991a). Various iron chemical compounds were identified such as ferrous sulfide, ferric nitrate, ferrous ammonium sulfate and ferrous sulfamate. Quantities ranged between 0.5 to approximately 450 kg in the 1974 inventory and 5 to 900 kg in 1988 inventory. However, iron was not carried forward as a material of concern for the ChemRisk process (CDH 1991b).

There is no record of iron waste being generated at RFETS (Table 4 and Table 7).

Iron was not identified above a RFCA AL requiring an accelerated action based on SAPs, SAP Addenda, or Closeout Reports for IHSSs and UBC sites.

In reviewing the iron soil data beneath the slabs for UBC sites (Figure 9), the summary statistics presented in Table 16 were generated.

**Table 16 UBC Soil Summary Statistics for Iron (mg/kg)**

| UBC | Analyte | Total Number of Samples | Detection Frequency > Background[19] | Mean | Maximum Concentration | Standard Deviation | Background Mean Plus 2SD | Unit |
|---|---|---|---|---|---|---|---|---|
| 122 | Iron | 6 | 0.00% | 11,367 | 15000 | 3,837 | 17,601 | mg/kg |
| 123 | Iron | 0 | NA | NA | NA | NA | 17,601 | mg/kg |
| 331 | Iron | 16 | 12.50% | 14,956 | 21000 | 2,998 | 17,601 | mg/kg |
| 371 | Iron | 1 | 0.00% | 7,200 | 7200 | NA | 17,601 | mg/kg |
| 374 | Iron | 3 | 0.00% | 10,367 | 17300 | 6,123 | 17,601 | mg/kg |
| 439 | Iron | 6 | 16.67% | 12,517 | 24300 | 5,960 | 17,601 | mg/kg |
| 440 | Iron | 10 | 10.00% | 12,500 | 18000 | 3,624 | 17,601 | mg/kg |
| 441 | Iron | 5 | 20.00% | 15,800 | 19000 | 2,387 | 17,601 | mg/kg |
| 442 | Iron | 11 | 9.09% | 13,415 | 17900 | 3,246 | 17,601 | mg/kg |
| 444 | Iron | 39 | 12.82% | 14,310 | 26000 | 4,243 | 17,601 | mg/kg |
| 445 | Iron | 1 | 100.00% | 21,000 | 21000 | NA | 17,601 | mg/kg |
| 447 | Iron | 17 | 52.94% | 18,647 | 29000 | 4,609 | 17,601 | mg/kg |
| 450 | Iron | 1 | 0.00% | 12,000 | 12000 | NA | 17,601 | mg/kg |
| 455 | Iron | 1 | 0.00% | 11,000 | 11000 | NA | 17,601 | mg/kg |
| 528 | Iron | 1 | 0.00% | 5,400 | 5400 | NA | 17,601 | mg/kg |
| 559 | Iron | 12 | 8.33% | 11,192 | 19000 | 3,853 | 17,601 | mg/kg |
| 701 | Iron | 4 | 25.00% | 15,500 | 21000 | 3,697 | 17,601 | mg/kg |
| 707 | Iron | 20 | 0.00% | 9,865 | 13000 | 1,800 | 17,601 | mg/kg |
| 712/713 | Iron | 12 | 58.33% | 20,567 | 54900 | 12,287 | 17,601 | mg/kg |
| 770 | Iron | 2 | 0.00% | 14,500 | 16000 | 2,121 | 17,601 | mg/kg |
| 771 | Iron | 12 | 16.67% | 15,000 | 19200 | 2,417 | 17,601 | mg/kg |
| 774 | Iron | 4 | 0.00% | 14,000 | 16000 | 1,414 | 17,601 | mg/kg |
| 776 | Iron | 20 | 15.00% | 13,015 | 19000 | 3,250 | 17,601 | mg/kg |
| 777 | Iron | 25 | 8.00% | 13,048 | 22000 | 3,513 | 17,601 | mg/kg |
| 778 | Iron | 15 | 13.33% | 12,473 | 21000 | 4,899 | 17,601 | mg/kg |
| 779 | Iron | 3 | 100.00% | 19,333 | 20000 | 1,155 | 17,601 | mg/kg |
| 865 | Iron | 25 | 16.00% | 13,564 | 24000 | 3,726 | 17,601 | mg/kg |
| 881 | Iron | 25 | 8.00% | 13,340 | 18300 | 2,444 | 17,601 | mg/kg |
| 883 | Iron | 12 | 66.67% | 21,242 | 30000 | 8,255 | 17,601 | mg/kg |
| 886 | Iron | 23 | 8.70% | 11,881 | 33000 | 5,567 | 17,601 | mg/kg |
| 889 | Iron | 3 | 66.67% | 22,867 | 31300 | 8,712 | 17,601 | mg/kg |
| 991 | Iron | 10 | 30.00% | 14,510 | 25000 | 4,731 | 17,601 | mg/kg |

NA = Not Applicable

[19] This column indicates those samples that were detected and greater than background. As a result, if this field shows 0% and a mean and maximum concentration are reported, the values represent those analytes detected but less than background.

### 2.1.10 Lead

Lead was mainly used for radiation shielding for plutonium operations (Building 300, 559 and 700) (CDH 1992; DOE 2004). A 1974 inventory indicated over 1 million pounds of lead. Molten lead was identified in Building 865. Lead was used for non-destructive testing in Building 460. Lead fluoride and lead metal were used in Building 771 for laboratory-scale attempts at lead/americium alloying. Lead fluoroborate and lead oxide were used in small quantities in plating operations. Process waste containing cadmium, chromium and lead were managed in Building 731 (plenum deluge and process waste pit for Building 707) and Building 528 (process waste handling building). Lead was also discharged as bullets at the East and North Firing Ranges. Lead gaskets were used in some of the older pipelines, mainly process waste and sanitary sewer lines.

Metallic lead was not considered a source of contamination in the ChemRisk reports. In the ChemRisk Task 1 report, several lead compounds were identified in a 1988/1989 chemical inventory list for Buildings 123, 559, 561, and 701 including acetate, chloride, iodide, metal, nitrate, oxide, and powder (CDH 1992). Lead compounds were carried forward as materials of concern for the ChemRisk reports. However, the Tasks 3 & 4 report indicated that based on the nature of their use they did not warrant further quantitative evaluation of potential off-site impacts. A comparison of the emission source maps with inventory quantities presented in the building summaries (Appendix B to the Tasks 3 & 4 report) indicated buildings or processes that used lead were not identified as emission sources. This was due to the manner in which the material was stored, processed, or handled and was not expected to lead to significant emissions.

In addition, lead was one of 5 metals (cadmium, chromium, lead, mercury, and nickel) included in a group of 13 chemicals that underwent extensive investigation by ChemRisk (CDH 1992). Results indicated that uses of these materials at RFETS had been extremely limited in scope or duration, associated with insignificant quantities of the material, or involved processes or forms of the materials, which were not expected to have significant off-site releases. These materials, therefore, did not warrant further quantitative evaluation as potential off-site impacts in the ChemRisk process.

Spills involving process wastes (containing cadmium, chromium, and lead) did occur within certain buildings, based on a review of RLCRs and PDSRs for these buildings. Specifically, history and process knowledge for Buildings 371, 374, and 559 revealed multiple spills of acids typically containing cadmium, chromium, and lead from the recovery of plutonium. These liquids may also have contained detectable levels of RCRA volatile organics such as carbon tetrachloride and perchloroethylene. A small number of randomly located concrete floor samples were collected and analyzed for RCRA metals and VOCs. All results indicated concentrations were below regulatory limits.

In addition, historical process knowledge for Buildings 771 and 774 indicate toxic metals were present in solutions and sludge/residues contained in process equipment, tanks, process lines, and waste containers. There were many incidents involving nitric acid solution spills that etched into the floor or walls. However, all sample results were below RCRA regulatory limits.

Lead waste has been generated from both laboratory and process buildings (Table 4 and Table 7).

Lead was identified as present in soil above the RFCA AL requiring an accelerated action based on SAPs, SAP Addenda, or Closeout Reports (and ER RFCA Standard Operating Protocol [RSOP] notifications for routine soil remediation) for IHSSs and UBC sites; specifically, lead was identified in soil at an underground storage tank associated with Building 441 (IHSS 400-128); UBC 123, and at both the East Firing Range (IHSS SE-1602) and North Firing Range (IHSS NW-1505). The lead concentrations at UBC 123 were associated with a lead-lined sump (not from a Site process), and the lead concentrations at the East and North Firing Ranges was due to the presence of discharged lead bullets (also not associated with a Site process).

In reviewing the lead soil data beneath the slabs for UBC sites (Figure 10), the summary statistics presented in Table 17 were generated.

**Table 17 UBC Soil Summary Statistics for Lead (mg/kg)**

| UBC | Analyte | Total Number of Samples | Detection Frequency > Background[20] | Mean | Maximum Concentration | Standard Deviation | Background Mean Plus 2SD | Unit |
|---|---|---|---|---|---|---|---|---|
| 122 | Lead | 6 | 0.00% | 12.3 | 34 | 11.3 | 54.6 | mg/kg |
| 123 | Lead | 0 | NA | NA | NA | NA | 54.6 | mg/kg |
| 331 | Lead | 16 | 12.50% | 25.4 | 170 | 43.4 | 54.6 | mg/kg |
| 371 | Lead | 1 | 0.00% | 3.40 | 3.4 | NA | 54.6 | mg/kg |
| 374 | Lead | 3 | 0.00% | 4.53 | 5.6 | 1.16 | 54.6 | mg/kg |
| 439 | Lead | 6 | 0.00% | 13.1 | 24 | 7.51 | 54.6 | mg/kg |
| 440 | Lead | 10 | 0.00% | 9.09 | 12 | 2.26 | 54.6 | mg/kg |
| 441 | Lead | 5 | 20.00% | 18.9 | 55 | 20.2 | 54.6 | mg/kg |
| 442 | Lead | 11 | 9.09% | 16.8 | 56.3 | 17.0 | 54.6 | mg/kg |
| 444 | Lead | 39 | 2.56% | 49.2 | 1500 | 239 | 54.6 | mg/kg |
| 445 | Lead | 1 | 0.00% | 12.0 | 12 | NA | 54.6 | mg/kg |
| 447 | Lead | 17 | 17.65% | 78.0 | 590 | 160 | 54.6 | mg/kg |
| 450 | Lead | 1 | 0.00% | 8.20 | 8.2 | NA | 54.6 | mg/kg |
| 455 | Lead | 1 | 0.00% | 13.0 | 13 | NA | 54.6 | mg/kg |
| 528 | Lead | 1 | 0.00% | 25.0 | 25 | NA | 54.6 | mg/kg |
| 559 | Lead | 12 | 0.00% | 8.93 | 17 | 3.66 | 54.6 | mg/kg |
| 701 | Lead | 4 | 0.00% | 15.3 | 21 | 4.19 | 54.6 | mg/kg |
| 707 | Lead | 20 | 0.00% | 7.75 | 15 | 2.21 | 54.6 | mg/kg |
| 712/713 | Lead | 12 | 8.33% | 21.9 | 69 | 19.2 | 54.6 | mg/kg |
| 770 | Lead | 2 | 0.00% | 15.0 | 17 | 2.83 | 54.6 | mg/kg |
| 771 | Lead | 12 | 0.00% | 14.5 | 22.4 | 5.24 | 54.6 | mg/kg |
| 774 | Lead | 4 | 0.00% | 16.0 | 19 | 2.58 | 54.6 | mg/kg |
| 776 | Lead | 20 | 5.00% | 13.2 | 79 | 15.8 | 54.6 | mg/kg |
| 777 | Lead | 25 | 4.00% | 25.7 | 330 | 64.5 | 54.6 | mg/kg |
| 778 | Lead | 15 | 0.00% | 8.33 | 14 | 2.36 | 54.6 | mg/kg |
| 779 | Lead | 3 | 0.00% | 8.13 | 8.8 | 0.702 | 54.6 | mg/kg |
| 865 | Lead | 25 | 4.00% | 20.2 | 250 | 48.1 | 54.6 | mg/kg |
| 881 | Lead | 25 | 0.00% | 8.94 | 16.3 | 3.73 | 54.6 | mg/kg |
| 883 | Lead | 12 | 0.00% | 13.5 | 34 | 7.75 | 54.6 | mg/kg |
| 886 | Lead | 23 | 0.00% | 7.95 | 27.9 | 4.91 | 54.6 | mg/kg |
| 889 | Lead | 3 | 0.00% | 9.97 | 11.6 | 1.70 | 54.6 | mg/kg |

[20] This column indicates those samples that were detected and greater than background. As a result, if this field shows 0% and a mean and maximum concentration are reported, the values represent those analytes detected but less than background.

| UBC | Analyte | Total Number of Samples | Detection Frequency > Background[20] | Mean | Maximum Concentration | Standard Deviation | Background Mean Plus 2SD | Unit |
|---|---|---|---|---|---|---|---|---|
| 991 | Lead | 10 | 0.00% | 11.4 | 26 | 6.31 | 54.6 | mg/kg |

NA = Not Applicable

### 2.1.11 Lithium

Lithium was not identified or discussed in building process information in the ChemRisk Task 3 & 4 report (CDH 1992). Lithium was identified as associated with mass spectrometry analysis performed in Building 559 and as being used in Building 881 for metalworking (DOE 2004). There are a few lithium sites such as at the 903 Pad area (IHSS 140), an area outside Building 331 (IHSS 134S), and IHSS Group 300-1.

Lithium was identified in the ChemRisk Task 1 report as various chemical compounds including lithium metal (CDH 1991a). Lithium was not carried forward as a material of concern for the ChemRisk reports because it was unlikely it would have posed a reproductive hazard to off-site individuals based on the quantity of the material used (CDH 1991b).

There is no record of spills involving lithium within these buildings, based on a review of RLCRs and PDSRs for these buildings.

Lithium waste has been generated from both laboratory and process buildings (Table 4 and Table 7). The waste for a majority of the buildings (6 out of 9) was lithium batteries. The remaining three buildings (559, 881 and 883) generated a processing agent that may have contained lithium aluminum hydride, lithium carbonate and alkaline lithium metal.

Lithium metal was treated in on-site disposal areas (IHSS 140-Reative Metals Destruction Site and IHSS 134-Lithium Metal Destruction Site), however lithium was not identified above a RFCA AL requiring an accelerated action at these IHSSs and based on SAPs, SAP Addenda, or Closeout Reports for additional IHSSs and UBC sites.

In reviewing the lithium soil beneath the slabs for UBC sites (Figure 11), the summary statistics presented in Table 18 were generated.

**Table 18 UBC Soil Summary Statistics for Lithium (mg/kg)**

| UBC | Analyte | Total Number of Samples | Detection Frequency > Background[21] | Mean | Maximum Concentration | Standard Deviation | Background Mean Plus 2SD | Unit |
|---|---|---|---|---|---|---|---|---|
| 122 | Lithium | 6 | 16.67% | 7.83 | 12 | 3.50 | 11.4 | mg/kg |
| 123 | Lithium | 0 | NA | NA | NA | NA | 11.4 | mg/kg |
| 331 | Lithium | 16 | 0.00% | 8.26 | 11 | 1.33 | 11.4 | mg/kg |
| 371 | Lithium | 1 | 0.00% | 3.70 | 3.7 | NA | 11.4 | mg/kg |
| 374 | Lithium | 3 | 0.00% | 4.83 | 6.6 | 2.04 | 11.4 | mg/kg |
| 439 | Lithium | 6 | 0.00% | 7.17 | 9.6 | 1.89 | 11.4 | mg/kg |

[21] This column indicates those samples that were detected and greater than background. As a result, if this field shows 0% and a mean and maximum concentration are reported, the values represent those analytes detected but less than background.

| UBC | Analyte | Total Number of Samples | Detection Frequency > Background[21] | Mean | Maximum Concentration | Standard Deviation | Background Mean Plus 2SD | Unit |
|---|---|---|---|---|---|---|---|---|
| 440 | Lithium | 10 | 40.00% | 10.1 | 15 | 3.69 | 11.4 | mg/kg |
| 441 | Lithium | 5 | 100.00% | 13.8 | 16 | 1.79 | 11.4 | mg/kg |
| 442 | Lithium | 11 | 45.45% | 11.0 | 16.9 | 3.52 | 11.4 | mg/kg |
| 444 | Lithium | 39 | 43.59% | 10.7 | 17 | 3.18 | 11.4 | mg/kg |
| 445 | Lithium | 1 | 100.00% | 16.0 | 16 | NA | 11.4 | mg/kg |
| 447 | Lithium | 17 | 70.59% | 12.9 | 20 | 3.11 | 11.4 | mg/kg |
| 450 | Lithium | 1 | 100.00% | 13.0 | 13 | NA | 11.4 | mg/kg |
| 455 | Lithium | 1 | 0.00% | 8.00 | 8 | NA | 11.4 | mg/kg |
| 528 | Lithium | 1 | 0.00% | 10.0 | 10 | NA | 11.4 | mg/kg |
| 559 | Lithium | 12 | 8.33% | 7.88 | 13 | 2.89 | 11.4 | mg/kg |
| 701 | Lithium | 4 | 0.00% | 9.75 | 11 | 1.21 | 11.4 | mg/kg |
| 707 | Lithium | 20 | 5.00% | 6.19 | 13 | 2.30 | 11.4 | mg/kg |
| 712/713 | Lithium | 12 | 41.67% | 11.6 | 22 | 5.33 | 11.4 | mg/kg |
| 770 | Lithium | 2 | 100.00% | 14.0 | 16 | 2.83 | 11.4 | mg/kg |
| 771 | Lithium | 12 | 16.67% | 9.10 | 17 | 3.29 | 11.4 | mg/kg |
| 774 | Lithium | 4 | 50.00% | 13.0 | 17 | 3.65 | 11.4 | mg/kg |
| 776 | Lithium | 20 | 40.00% | 11.3 | 18 | 3.36 | 11.4 | mg/kg |
| 777 | Lithium | 25 | 28.00% | 10.2 | 23 | 3.62 | 11.4 | mg/kg |
| 778 | Lithium | 15 | 33.33% | 9.42 | 18 | 4.98 | 11.4 | mg/kg |
| 779 | Lithium | 3 | 100.00% | 23.0 | 32 | 8.54 | 11.4 | mg/kg |
| 865 | Lithium | 25 | 20.00% | 10.3 | 21 | 3.97 | 11.4 | mg/kg |
| 881 | Lithium | 25 | 48.00% | 11.6 | 15.1 | 1.58 | 11.4 | mg/kg |
| 883 | Lithium | 12 | 58.33% | 12.4 | 18 | 3.71 | 11.4 | mg/kg |
| 886 | Lithium | 23 | 21.74% | 8.44 | 14 | 3.18 | 11.4 | mg/kg |
| 889 | Lithium | 3 | 33.33% | 10.8 | 11.5 | 0.751 | 11.4 | mg/kg |
| 991 | Lithium | 10 | 40.00% | 11.0 | 20 | 4.29 | 11.4 | mg/kg |

NA = Not Applicable

### 2.1.12 Manganese

Manganese was not identified or discussed in building process information (CDH 1992; DOE 2004). Manganese has not been found associated with UBC sites (DOE 2004).

Manganese was initially identified in the ChemRisk Task 1 report as a chemical in inventory at RFETS (although no specific building was identified). Several manganese chemical compounds were identified in the Task 1 report in the form of carbonate, chips, dioxide, flake, II oxide, metal, monoxide, powder, chloride, nitrate and sulfate (CDH 1991a, 1991b). Only small quantities were identified to be in inventory, with the exception of manganous sulfate which had an inventory in 1974 of 2,560 kg, and then later in 1988 of 0.06 kg. It is assumed that manganese was carried forward in the ChemRisk process based on the quantity of sulfate.

In the ChemRisk Task 2 report (stage 2 screening), manganese was identified as an essential nutrient for humans. The safe and adequate dietary allowance of manganese recommended for an adult was 10 mg/day (Based on a 1963 California State Water Resources Control Board concentration [CDH 1991b]). Using the exposure scenarios described, concentrations of manganese in air and water were calculated. Based on these doses, it was determined that manganese was unlikely to pose a health hazard to off-site individuals and was not carried forward as a material of concern for the ChemRisk process. In addition, the predicted air concentration was approximately 1,000 times lower than the occupational air standard.

There is no record of manganese waste being generated at RFETS (Table 4 and Table 7).

Manganese was not identified above a RFCA AL requiring an accelerated action based on Closeout Reports for IHSSs and UBC sites.

In reviewing the manganese soil data beneath the slabs for UBC sites (Figure 12), the summary statistics presented in Table 19 were generated.

**Table 19 UBC Soil Summary Statistics for Manganese (mg/kg)**

| UBC | Analyte | Total Number of Samples | Detection Frequency > Background[22] | Mean | Maximum Concentration | Standard Deviation | Background Mean Plus 2SD | Unit |
|---|---|---|---|---|---|---|---|---|
| 122 | Manganese | 6 | 0.00% | 108 | 170 | 36.8 | 365 | mg/kg |
| 123 | Manganese | 0 | NA | NA | NA | NA | 365 | mg/kg |
| 331 | Manganese | 16 | 0.00% | 125 | 190 | 30.8 | 365 | mg/kg |
| 371 | Manganese | 1 | 0.00% | 63.0 | 63 | NA | 365 | mg/kg |
| 374 | Manganese | 3 | 0.00% | 156 | 333 | 155 | 365 | mg/kg |
| 439 | Manganese | 6 | 16.67% | 224 | 484 | 132 | 365 | mg/kg |
| 440 | Manganese | 10 | 0.00% | 159 | 250 | 55.3 | 365 | mg/kg |
| 441 | Manganese | 5 | 0.00% | 134 | 180 | 30.5 | 365 | mg/kg |
| 442 | Manganese | 11 | 0.00% | 147 | 247 | 71.8 | 365 | mg/kg |
| 444 | Manganese | 39 | 7.69% | 216 | 670 | 113 | 365 | mg/kg |
| 445 | Manganese | 1 | 0.00% | 100 | 100 | NA | 365 | mg/kg |
| 447 | Manganese | 17 | 5.88% | 216 | 550 | 103 | 365 | mg/kg |
| 450 | Manganese | 1 | 0.00% | 180 | 180 | NA | 365 | mg/kg |
| 455 | Manganese | 1 | 0.00% | 190 | 190 | NA | 365 | mg/kg |
| 528 | Manganese | 1 | 0.00% | 15.0 | 15 | NA | 365 | mg/kg |
| 559 | Manganese | 12 | 8.33% | 166 | 430 | 102 | 365 | mg/kg |
| 701 | Manganese | 4 | 0.00% | 195 | 240 | 31.1 | 365 | mg/kg |
| 707 | Manganese | 20 | 0.00% | 133 | 310 | 55.1 | 365 | mg/kg |
| 712/713 | Manganese | 12 | 8.33% | 211 | 417 | 87.1 | 365 | mg/kg |
| 770 | Manganese | 2 | 0.00% | 255 | 280 | 35.4 | 365 | mg/kg |
| 771 | Manganese | 12 | 0.00% | 150 | 229 | 51.7 | 365 | mg/kg |
| 774 | Manganese | 4 | 0.00% | 166 | 230 | 97.2 | 365 | mg/kg |
| 776 | Manganese | 20 | 0.00% | 177 | 270 | 47.5 | 365 | mg/kg |
| 777 | Manganese | 25 | 8.00% | 204 | 550 | 93.9 | 365 | mg/kg |
| 778 | Manganese | 15 | 13.33% | 226 | 660 | 150 | 365 | mg/kg |
| 779 | Manganese | 3 | 0.00% | 179 | 270 | 109 | 365 | mg/kg |
| 865 | Manganese | 25 | 4.00% | 213 | 510 | 86.9 | 365 | mg/kg |
| 881 | Manganese | 25 | 0.00% | 176 | 276 | 41.7 | 365 | mg/kg |
| 883 | Manganese | 12 | 58.33% | 392 | 650 | 233 | 365 | mg/kg |
| 886 | Manganese | 23 | 0.00% | 160 | 317 | 66.0 | 365 | mg/kg |
| 889 | Manganese | 3 | 66.67% | 425 | 556 | 172 | 365 | mg/kg |

[22] This column indicates those samples that were detected and greater than background. As a result, if this field shows 0% and a mean and maximum concentration are reported, the values represent those analytes detected but less than background.

| UBC | Analyte | Total Number of Samples | Detection Frequency > Background[22] | Mean | Maximum Concentration | Standard Deviation | Background Mean Plus 2SD | Unit |
|---|---|---|---|---|---|---|---|---|
| 991 | Manganese | 10 | 10.00% | 176 | 420 | 92.2 | 365 | mg/kg |

NA = Not Applicable

### 2.1.13 Mercury

Mercury used at RFETS was, for the most part, limited to the metallic mercury contained in instruments such as barometers, manometers, and thermometers; plant machinery; mercury switches; and experimental apparatus (CDH 1992). Mercury was not used in production processes. A welding operation in Building 777 used mercury to make contact with spinning parts during welding. Mercury was collected from Plant sources and purified by distillation at Building 881; the General Laboratory. It was recycled back to the originating area in 5-pound containers.

Mercury, with the following exceptions, has not been found associated with UBC sites (DOE 2004). Mercury was found at Building 443 in the subfloor piping. It did not occur outside the pipes. Its presence was expected to be as a result from a broken gauge. There was also a report of a broken mercury gauge in Building 447 (steam plant).

Mercury was identified in the ChemRisk reports as both a chemical and metal. Materials present in 1971 included mercuric chloride, mercuric oxide, mercury/thallium batteries, electrodes, fluorescent lamps, and rectifiers (CDH 1991a). Mercury identified in a 1988/1989 chemical inventory list for Buildings 559, 561, and 886 included acetate, chloride, iodide, nitrate, oxide, sulfate and metal.

Mercury compounds were carried forward as materials of concern for the ChemRisk reports (CDH 1992). However, the Tasks 3 & 4 report indicated that, based on the nature of their use, they did not warrant further quantitative evaluation of potential off-site impacts. A comparison of the emission source maps with inventory quantities presented in the building summaries (Appendix B to the Tasks 3 & 4 report) indicated buildings or processes that used mercury were not identified as emission sources. This was due to the manner in which the material was stored, processed, or handled and was not expected to lead to significant emissions. In addition, on a number of the emission source maps, the waste treatment buildings were identified as air emission sources for chemicals that were not expected to be released in significant quantities in their primary areas of use as indicated by inventory.

In addition, mercury was one of 5 metals (cadmium, chromium lead, mercury, and nickel) included in a group of 13 chemicals that underwent extensive investigation by ChemRisk (CDH 1992). Results indicated uses of these materials at RFETS had been extremely limited in scope or duration, associated with insignificant quantities of the material, or involved processes or forms of the materials that were not expected to have significant off-site releases. These materials, therefore, did not warrant further quantitative evaluation as potential off-site impacts in the ChemRisk process.

There is no record of spills involving mercury compounds within a majority of these buildings, based on a review of RLCRs and PDSRs for these buildings. Mercury was identified as a spill within Building 774; however, mercury was not identified as a contaminant of concern for this building because it was expected that this spill was properly remediated (K-H 1998).

Mercury waste has been generated from both laboratory and process buildings (Tàble 4 and Table 7).

Mercury was not identified above a RFCA AL requiring an accelerated action based on SAPs, SAP Addenda, or Closeout Reports for IHSSs and UBC sites.

In reviewing the mercury soil data beneath the slabs for UBC sites (Figure 13), the summary statistics presented in Table 20 were generated.

**Table 20 UBC Soil Summary Statistics for Mercury (mg/kg)**

| UBC | Analyte | Total Number of Samples | Detection Frequency > Background[23] | Mean | Maximum Concentration | Standard Deviation | Background Mean Plus 2SD | Unit |
|---|---|---|---|---|---|---|---|---|
| 122 | Mercury | 6 | 0.00% | 0.036 | 0.1 | 0.039 | 0.133 | mg/kg |
| 123 | Mercury | 0 | NA | NA | NA | NA | 0.133 | mg/kg |
| 331 | Mercury | 16 | 0.00% | 0.053 | 0.11 | 0.026 | 0.133 | mg/kg |
| 371 | Mercury | 0 | NA | NA | NA | NA | 0.133 | mg/kg |
| 374 | Mercury | 1 | 0.00% | ND | ND | ND | 0.133 | mg/kg |
| 439 | Mercury | 6 | 0.00% | 0.009 | 0.0088 | 0.008 | 0.133 | mg/kg |
| 440 | Mercury | 10 | 0.00% | 0.027 | 0.065 | 0.022 | 0.133 | mg/kg |
| 441 | Mercury | 5 | 80.00% | 0.330 | 0.58 | 0.226 | 0.133 | mg/kg |
| 442 | Mercury | 11 | 0.00% | 0.043 | 0.13 | 0.040 | 0.133 | mg/kg |
| 444 | Mercury | 39 | 2.56% | 0.033 | 0.22 | 0.040 | 0.133 | mg/kg |
| 445 | Mercury | 1 | 0.00% | 0.095 | 0.095 | NA | 0.133 | mg/kg |
| 447 | Mercury | 17 | 0.00% | 0.038 | 0.081 | 0.021 | 0.133 | mg/kg |
| 450 | Mercury | 1 | 0.00% | 0.046 | 0.046 | NA | 0.133 | mg/kg |
| 455 | Mercury | 1 | 0.00% | 0.009 | 0.0091 | NA | 0.133 | mg/kg |
| 528 | Mercury | 1 | 0.00% | 0.081 | 0.081 | NA | 0.133 | mg/kg |
| 559 | Mercury | 12 | 0.00% | 0.051 | 0.1 | 0.026 | 0.133 | mg/kg |
| 701 | Mercury | 4 | 0.00% | 0.050 | 0.084 | 0.029 | 0.133 | mg/kg |
| 707 | Mercury | 20 | 0.00% | 0.011 | 0.069 | 0.015 | 0.133 | mg/kg |
| 712/713 | Mercury | 12 | 33.33% | 0.091 | 0.22 | 0.072 | 0.133 | mg/kg |
| 770 | Mercury | 2 | 0.00% | 0.021 | 0.028 | 0.010 | 0.133 | mg/kg |
| 771 | Mercury | 12 | 0.00% | 0.039 | 0.082 | 0.023 | 0.133 | mg/kg |
| 774 | Mercury | 4 | 0.00% | 0.053 | 0.096 | 0.030 | 0.133 | mg/kg |
| 776 | Mercury | 20 | 0.00% | 0.030 | 0.098 | 0.030 | 0.133 | mg/kg |
| 777 | Mercury | 25 | 4.00% | 0.026 | 0.18 | 0.041 | 0.133 | mg/kg |
| 778 | Mercury | 15 | 0.00% | 0.015 | 0.029 | 0.009 | 0.133 | mg/kg |
| 779 | Mercury | 3 | 66.67% | 0.137 | 0.15 | 0.015 | 0.133 | mg/kg |
| 865 | Mercury | 24 | 0.00% | 0.011 | 0.028 | 0.007 | 0.133 | mg/kg |
| 881 | Mercury | 25 | 0.00% | 0.017 | 0.087 | 0.020 | 0.133 | mg/kg |
| 883 | Mercury | 12 | 8.33% | 0.031 | 0.14 | 0.039 | 0.133 | mg/kg |
| 886 | Mercury | 23 | 4.35% | 0.026 | 0.15 | 0.028 | 0.133 | mg/kg |
| 889 | Mercury | 3 | 0.00% | 0.008 | 0.016 | 0.008 | 0.133 | mg/kg |

[23] This column indicates those samples that were detected and greater than background. As a result, if this field shows 0% and a mean and maximum concentration are reported, the values represent those analytes detected but less than background.

| UBC | Analyte | Total Number of Samples | Detection Frequency > Background[23] | Mean | Maximum Concentration | Standard Deviation | Background Mean Plus 2SD | Unit |
|---|---|---|---|---|---|---|---|---|
| 991 | Mercury | 8 | 0.00% | 0.040 | 0.11 | 0.041 | 0.133 | mg/kg |

NA = Not Applicable ND = Not Detected

### 2.1.14 Molybdenum

The Zero Power Plutonium Reactor (ZPPR or "zipper") project manufactured stainless steel clad fuel elements consisting of plutonium, molybdenum, and uranium from 1967 to 1968 (CDH 1992). The ZPPR fuel elements were made first by alloying the uranium and molybdenum in Building 444. The alloy was then sent to Building 771, where it was alloyed with Plutonium by casting into plates of various sizes. The ternary alloy plates were clad in stainless steel envelopes in Buildings 776/777 and sealed by welding.

The metallurgical operations in Building 865 began in 1970 and involved the development of alloys (CDH 1992). Some of the metals employed in the alloying development included aluminum, copper, magnesium, molybdenum, niobium, platinum, stainless steel, tantalum, titanium, and vanadium.

The buildings identified above involved radiological operations and included extensive HEPA filtration systems. Any emissions from machining molybdenum would have been collected on these filters prior to release from the buildings.

Molybdenum was initially identified in the ChemRisk Task 1 report as various chemical compounds in inventory at RFETS (CDH 1991b). Based on the estimated quantity of these chemicals used, molybdenum was not carried forward as a material of concern for the ChemRisk process.

Acid waste containing molybdenum was generated from Building 559.

Molybdenum was not identified above a RFCA AL requiring an accelerated action based on SAPs, SAP Addenda, or Closeout Reports for IHSSs and UBC sites.

In reviewing the molybdenum soil data beneath the slabs for UBC sites (Figure 14), the summary statistics presented in Table 21 were generated.

**Table 21 UBC Soil Summary Statistics for Molybdenum (mg/kg)**

| UBC | Analyte | Total Number of Samples | Detection Frequency > Background[24] | Mean | Maximum Concentration | Standard Deviation | Background Mean Plus 2SD | Unit |
|---|---|---|---|---|---|---|---|---|
| 122 | Molybdenum | 6 | 16.67% | 0.677 | 1 | 0.237 | 0.941 | mg/kg |
| 123 | Molybdenum | 0 | NA | NA | NA | NA | 0.941 | mg/kg |
| 331 | Molybdenum | 16 | 18.75% | 0.766 | 1.2 | 0.244 | 0.941 | mg/kg |
| 371 | Molybdenum | 1 | 0.00% | 0.190 | 0.19 | NA | 0.941 | mg/kg |
| 374 | Molybdenum | 3 | 0.00% | 0.500 | 0.41 | 0.363 | 0.941 | mg/kg |

[24] This column indicates those samples that were detected and greater than background. As a result, if this field shows 0% and a mean and maximum concentration are reported, the values represent those analytes detected but less than background.

| UBC | Analyte | Total Number of Samples | Detection Frequency > Background[24] | Mean | Maximum Concentration | Standard Deviation | Background Mean Plus 2SD | Unit |
|---|---|---|---|---|---|---|---|---|
| 439 | Molybdenum | 6 | 0.00% | 0.373 | 0.66 | 0.209 | 0.941 | mg/kg |
| 440 | Molybdenum | 10 | 0.00% | 0.540 | 0.84 | 0.220 | 0.941 | mg/kg |
| 441 | Molybdenum | 5 | 0.00% | 0.370 | 0.55 | 0.131 | 0.941 | mg/kg |
| 442 | Molybdenum | 11 | 9.09% | 0.266 | 1.3 | 0.350 | 0.941 | mg/kg |
| 444 | Molybdenum | 39 | 5.13% | 0.375 | 1 | 0.234 | 0.941 | mg/kg |
| 445 | Molybdenum | 1 | 0.00% | 0.690 | 0.69 | NA | 0.941 | mg/kg |
| 447 | Molybdenum | 17 | 11.76% | 0.472 | 0.99 | 0.301 | 0.941 | mg/kg |
| 450 | Molybdenum | 1 | 0.00% | ND | ND | ND | 0.941 | mg/kg |
| 455 | Molybdenum | 1 | 0.00% | ND | ND | ND | 0.941 | mg/kg |
| 528 | Molybdenum | 1 | 0.00% | ND | ND | ND | 0.941 | mg/kg |
| 559 | Molybdenum | 12 | 8.33% | 0.485 | 0.96 | 0.264 | 0.941 | mg/kg |
| 701 | Molybdenum | 4 | 0.00% | 0.413 | 0.69 | 0.293 | 0.941 | mg/kg |
| 707 | Molybdenum | 20 | 15.00% | 0.715 | 2.9 | 0.559 | 0.941 | mg/kg |
| 712/713 | Molybdenum | 12 | 25.00% | 1.41 | 9.7 | 2.63 | 0.941 | mg/kg |
| 770 | Molybdenum | 2 | 0.00% | 0.580 | 0.72 | 0.198 | 0.941 | mg/kg |
| 771 | Molybdenum | 12 | 25.00% | 0.593 | 1.6 | 0.538 | 0.941 | mg/kg |
| 774 | Molybdenum | 4 | 0.00% | 0.380 | 0.86 | 0.349 | 0.941 | mg/kg |
| 776 | Molybdenum | 20 | 10.00% | 0.414 | 1.5 | 0.385 | 0.941 | mg/kg |
| 777 | Molybdenum | 25 | 12.00% | 0.847 | 9.5 | 1.86 | 0.941 | mg/kg |
| 778 | Molybdenum | 15 | 6.67% | 0.349 | 1.2 | 0.299 | 0.941 | mg/kg |
| 779 | Molybdenum | 3 | 0.00% | 0.553 | 0.83 | 0.246 | 0.941 | mg/kg |
| 865 | Molybdenum | 25 | 4.00% | 0.251 | 1 | 0.211 | 0.941 | mg/kg |
| 881 | Molybdenum | 25 | 4.00% | 0.197 | 1.5 | 0.309 | 0.941 | mg/kg |
| 883 | Molybdenum | 12 | 50.00% | 1.01 | 2.4 | 0.524 | 0.941 | mg/kg |
| 886 | Molybdenum | 23 | 8.70% | 0.492 | 3.9 | 0.794 | 0.941 | mg/kg |
| 889 | Molybdenum | 3 | 0.00% | 0.180 | 0.39 | 0.182 | 0.941 | mg/kg |
| 991 | Molybdenum | 10 | 0.00% | 0.324 | 0.9 | 0.252 | 0.941 | mg/kg |

NA = Not Applicable ND = Not Detected

### 2.1.15 Nickel

Nickel carbonyl plating was conducted in Buildings 771, 777, and 779 from the early 1950s until the early 1960s or 1970s (CDH 1992). Nickel plating by nickel carbonyl decomposition was used for uranium and delta phase (alloyed) plutonium. The waste chemistry group (Building 881 R&D) supported the Joining Technology Department to join non-nuclear metals including beryllium and in some cases using brazing alloys including nickel. Nickel plating of weapon components was conducted in Building 444 up until shutdown of the plating lab in 1990. Some plating solutions were made by mixing metal salts with acids, others were purchased in aqueous form. Nickel plating solutions were heated and used in 75-gallon tanks. Some liquid evaporated; however, measurements showed that the metals did not.

Before RCRA, plating wastes were treated in Building 774 (CDH 1992). Dilute rinsates were sent to Building 374. Prior to Building 374, the Solar Evaporation Ponds were used to treat wastewater. Building 991 was used as the product warehouse where components containing plutonium, uranium, and nickel were assembled into final products.

Nickel was found to be associated with anion exchange resins in Building 371 (DOE 2004).

The buildings identified above involved radiological operations and included extensive HEPA filtration systems. Any emissions from machining or plating nickel would have been collected on these filters prior to release from the buildings.

Nickel compounds were carried forward as materials of concern for the ChemRisk reports (CDH 1992). However, the Tasks 3 & 4 report indicated that, based on the nature of their use, they did not warrant further quantitative evaluation of potential off-site impacts. A comparison of the emission source maps with inventory quantities presented in the building summaries (Appendix B to the Tasks 3 & 4 report) indicated buildings or processes that used nickel were not identified as emission sources. This was due to the manner in which the material was stored, processed, or handled and was not expected to lead to significant emissions. In addition, on a number of the emission source maps, the waste treatment buildings were identified as air emission sources for chemicals that were not expected to be released in significant quantities in their primary areas of use as indicated by the inventory.

In addition, nickel was one of 5 metals (cadmium, chromium lead, mercury, and nickel) included in a group of 13 chemicals that underwent extensive investigation by ChemRisk (CDH 1992). Results indicated uses of these materials at RFETS had been extremely limited in scope or duration, associated with insignificant quantities of the material, or involved processes or forms of the materials that were not expected to have significant off-site releases. These materials therefore did not warrant further quantitative evaluation as potential off-site impacts in the ChemRisk process.

There is no record of spills involving nickel compounds within these buildings, based on a review of RLCRs and PDSRs for these buildings.

Waste containing nickel as an underlying hazardous constituent has been generated from both laboratory and process buildings (Table 4 and Table 7).

Nickel carbonyl canisters were stored and/or vented outside at three locations. Nickel was not identified above a RFCA AL requiring an accelerated action based on SAPs, SAP Addenda, or Closeout Reports for IHSSs and UBC sites.

In reviewing the nickel soil data beneath the slabs for UBC sites (Figure 15), the summary statistics presented in Table 22 were generated.

**Table 22 UBC Soil Summary Statistics for Nickel (mg/kg)**

| UBC | Analyte | Total Number of Samples | Detection Frequency > Background[25] | Mean | Maximum Concentration | Standard Deviation | Background Mean Plus 2SD | Unit |
|---|---|---|---|---|---|---|---|---|
| 122 | Nickel | 6 | 16.67% | 9.08 | 16 | 5.29 | 14.8 | mg/kg |
| 123 | Nickel | 0 | NA | NA | NA | NA | 14.8 | mg/kg |
| 331 | Nickel | 16 | 50.00% | 16.4 | 38 | 7.79 | 14.8 | mg/kg |
| 371 | Nickel | 1 | 0.00% | 2.80 | 2.8 | NA | 14.8 | mg/kg |
| 374 | Nickel | 3 | 33.33% | 7.57 | 15.7 | 7.13 | 14.8 | mg/kg |

[25] This column indicates those samples that were detected and greater than background. As a result, if this field shows 0% and a mean and maximum concentration are reported, the values represent those analytes detected but less than background.

| UBC | Analyte | Total Number of Samples | Detection Frequency > Background[25] | Mean | Maximum Concentration | Standard Deviation | Background Mean Plus 2SD | Unit |
|---|---|---|---|---|---|---|---|---|
| 439 | Nickel | 6 | 0.00% | 7.67 | 13.1 | 3.27 | 14.8 | mg/kg |
| 440 | Nickel | 10 | 40.00% | 12.8 | 21 | 5.46 | 14.8 | mg/kg |
| 441 | Nickel | 5 | 60.00% | 16.2 | 20 | 3.11 | 14.8 | mg/kg |
| 442 | Nickel | 11 | 36.36% | 12.8 | 19.1 | 4.20 | 14.8 | mg/kg |
| 444 | Nickel | 39 | 43.59% | 13.8 | 21 | 3.92 | 14.8 | mg/kg |
| 445 | Nickel | 1 | 100.00% | 21.0 | 21 | NA | 14.8 | mg/kg |
| 447 | Nickel | 17 | 76.47% | 16.2 | 22 | 4.03 | 14.8 | mg/kg |
| 450 | Nickel | 1 | 100.00% | 18.0 | 18 | NA | 14.8 | mg/kg |
| 455 | Nickel | 1 | 0.00% | 5.10 | 5.1 | NA | 14.8 | mg/kg |
| 528 | Nickel | 1 | 100.00% | 20.0 | 20 | NA | 14.8 | mg/kg |
| 559 | Nickel | 12 | 25.00% | 11.7 | 25 | 5.74 | 14.8 | mg/kg |
| 701 | Nickel | 4 | 75.00% | 15.0 | 19 | 3.74 | 14.8 | mg/kg |
| 707 | Nickel | 20 | 0.00% | 6.43 | 13 | 2.26 | 14.8 | mg/kg |
| 712/713 | Nickel | 12 | 66.67% | 17.7 | 45 | 11.7 | 14.8 | mg/kg |
| 770 | Nickel | 2 | 50.00% | 16.0 | 20 | 5.66 | 14.8 | mg/kg |
| 771 | Nickel | 12 | 83.33% | 18.0 | 31 | 6.49 | 14.8 | mg/kg |
| 774 | Nickel | 4 | 50.00% | 13.7 | 16 | 3.35 | 14.8 | mg/kg |
| 776 | Nickel | 20 | 45.00% | 14.8 | 37 | 7.48 | 14.8 | mg/kg |
| 777 | Nickel | 25 | 40.00% | 18.5 | 77 | 18.3 | 14.8 | mg/kg |
| 778 | Nickel | 15 | 26.67% | 12.1 | 22 | 4.99 | 14.8 | mg/kg |
| 779 | Nickel | 3 | 100.00% | 20.0 | 22 | 2.65 | 14.8 | mg/kg |
| 865 | Nickel | 25 | 20.00% | 10.7 | 23 | 5.00 | 14.8 | mg/kg |
| 881 | Nickel | 25 | 28.00% | 15.3 | 56.7 | 9.20 | 14.8 | mg/kg |
| 883 | Nickel | 12 | 66.67% | 15.9 | 22 | 5.07 | 14.8 | mg/kg |
| 886 | Nickel | 23 | 17.39% | 11.4 | 18.4 | 3.47 | 14.8 | mg/kg |
| 889 | Nickel | 3 | 66.67% | 18.3 | 24.6 | 6.15 | 14.8 | mg/kg |
| 991 | Nickel | 10 | 60.00% | 14.4 | 27 | 7.86 | 14.8 | mg/kg |

NA = Not Applicable

### 2.1.16 Selenium

Selenium was not identified or discussed in building process information (CDH 1992; DOE 2004). Selenium has not been found associated with UBC sites (DOE 2004).

Selenium compounds were initially identified in the ChemRisk Task 1 report in inventory at RFETS (although no specific building was identified) in the form of dioxide, oxide, pellets, and powder. These chemicals appeared to have been used as laboratory standards or analytical testing materials because they were used in very small quantities (CDH 1991b). Based on the estimated quantity of these chemicals used, selenium was not carried forward as a material of concern for the ChemRisk process.

Small amounts of selenium waste have been generated from both laboratory and process buildings (Table 4 and Table 7).

Selenium was not identified above a RFCA AL requiring an accelerated action based on Closeout Reports for IHSSs and UBC sites.

In reviewing the selenium soil data beneath the slabs for UBC sites (Figure 16), the summary statistics presented in Table 23 were generated.

**Table 23 UBC Soil Summary Statistics for Selenium (mg/kg)**

| UBC | Analyte | Total Number of Samples | Detection Frequency > Background[26] | Mean | Maximum Concentration | Standard Deviation | Background Mean Plus 2SD | Unit |
|---|---|---|---|---|---|---|---|---|
| 122 | Selenium | 6 | 0.00% | ND | ND | ND | 1.24 | mg/kg |
| 123 | Selenium | 0 | NA | NA | NA | NA | 1.24 | mg/kg |
| 331 | Selenium | 16 | 0.00% | ND | ND | ND | 1.24 | mg/kg |
| 371 | Selenium | 1 | 0.00% | ND | ND | ND | 1.24 | mg/kg |
| 374 | Selenium | 3 | 0.00% | ND | ND | ND | 1.24 | mg/kg |
| 439 | Selenium | 6 | 0.00% | ND | ND | ND | 1.24 | mg/kg |
| 440 | Selenium | 10 | 0.00% | ND | ND | ND | 1.24 | mg/kg |
| 441 | Selenium | 5 | 0.00% | ND | ND | ND | 1.24 | mg/kg |
| 442 | Selenium | 11 | 0.00% | ND | ND | ND | 1.24 | mg/kg |
| 444 | Selenium | 39 | 15.38% | 0.741 | 2.1 | 0.442 | 1.24 | mg/kg |
| 445 | Selenium | 1 | 100.00% | 1.80 | 1.8 | NA | 1.24 | mg/kg |
| 447 | Selenium | 17 | 0.00% | 0.475 | 1.2 | 0.189 | 1.24 | mg/kg |
| 450 | Selenium | 1 | 100.00% | 1.30 | 1.3 | NA | 1.24 | mg/kg |
| 455 | Selenium | 1 | 0.00% | ND | ND | ND | 1.24 | mg/kg |
| 528 | Selenium | 1 | 0.00% | ND | ND | ND | 1.24 | mg/kg |
| 559 | Selenium | 12 | 0.00% | ND | ND | ND | 1.24 | mg/kg |
| 701 | Selenium | 4 | 0.00% | ND | ND | ND | 1.24 | mg/kg |
| 707 | Selenium | 20 | 0.00% | ND | ND | ND | 1.24 | mg/kg |
| 712/713 | Selenium | 12 | 0.00% | 0.388 | 0.45 | 0.101 | 1.24 | mg/kg |
| 770 | Selenium | 2 | 0.00% | ND | ND | ND | 1.24 | mg/kg |
| 771 | Selenium | 12 | 0.00% | 0.296 | 0.729 | 0.165 | 1.24 | mg/kg |
| 774 | Selenium | 4 | 0.00% | ND | ND | ND | 1.24 | mg/kg |
| 776 | Selenium | 20 | 0.00% | ND | ND | ND | 1.24 | mg/kg |
| 777 | Selenium | 25 | 0.00% | ND | ND | ND | 1.24 | mg/kg |
| 778 | Selenium | 15 | 0.00% | 0.432 | 0.88 | 0.125 | 1.24 | mg/kg |
| 779 | Selenium | 3 | 0.00% | ND | ND | ND | 1.24 | mg/kg |
| 865 | Selenium | 25 | 0.00% | ND | ND | ND | 1.24 | mg/kg |
| 881 | Selenium | 25 | 0.00% | ND | ND | ND | 1.24 | mg/kg |
| 883 | Selenium | 12 | 0.00% | ND | ND | ND | 1.24 | mg/kg |
| 886 | Selenium | 23 | 0.00% | 0.234 | 0.85 | 0.139 | 1.24 | mg/kg |
| 889 | Selenium | 3 | 0.00% | ND | ND | ND | 1.24 | mg/kg |
| 991 | Selenium | 10 | 0.00% | 0.495 | 1.1 | 0.215 | 1.24 | mg/kg |

NA = Not Applicable ND = Not Detected

### 2.1.17 Strontium

Strontium was not identified or discussed in building process information (CDH 1992; DOE 2004). Strontium has not been found associated with UBC sites (DOE 2004).

[26] This column indicates those samples that were detected and greater than background. As a result, if this field shows 0% and a mean and maximum concentration are reported, the values represent those analytes detected but less than background.

Strontium compounds were initially identified in the ChemRisk Task 1 report in inventory at RFETS (although no specific building was identified) in the form of carbonate, chloride, fluoride, nitrate, oxide, sulfide, and zirconate. These chemicals appeared to have been used as laboratory standards or analytical testing materials because they were used in very small quantities (CDH 1991b). Based on the estimated quantity of these chemicals used, strontium was not carried forward as a material of concern for the ChemRisk process.

There is no indication that strontium waste has been generated from on-site operations (Table 4 and Table 7).

Strontium was not identified above a RFCA AL requiring an accelerated action based on SAPs, SAP Addenda, or Closeout Reports for IHSSs and UBCs.

In reviewing the strontium soil data beneath the slabs for UBC sites (Figure 17), the summary statistics presented in Table 24 were generated.

**Table 24 UBC Soil Summary Statistics for Strontium (mg/kg)**

| UBC | Analyte | Total Number of Samples | Detection Frequency > Background[27] | Mean | Maximum Concentration | Standard Deviation | Background Mean Plus 2SD | Unit |
|---|---|---|---|---|---|---|---|---|
| 122 | Strontium | 6 | 0.00% | 17.5 | 34 | 9.44 | 48.8 | mg/kg |
| 123 | Strontium | 0 | NA | NA | NA | NA | 48.8 | mg/kg |
| 331 | Strontium | 16 | 12.50% | 28.9 | 78 | 17.5 | 48.8 | mg/kg |
| 371 | Strontium | 1 | 0.00% | 8.30 | 8.3 | NA | 48.8 | mg/kg |
| 374 | Strontium | 3 | 0.00% | 19.0 | 37.8 | 16.3 | 48.8 | mg/kg |
| 439 | Strontium | 6 | 0.00% | 11.9 | 16.5 | 3.46 | 48.8 | mg/kg |
| 440 | Strontium | 10 | 0.00% | 22.0 | 35 | 7.71 | 48.8 | mg/kg |
| 441 | Strontium | 5 | 0.00% | 26.4 | 43 | 10.1 | 48.8 | mg/kg |
| 442 | Strontium | 11 | 27.27% | 35.9 | 79 | 19.2 | 48.8 | mg/kg |
| 444 | Strontium | 39 | 10.26% | 32.9 | 120 | 20.4 | 48.8 | mg/kg |
| 445 | Strontium | 1 | 0.00% | 24.0 | 24 | NA | 48.8 | mg/kg |
| 447 | Strontium | 17 | 23.53% | 36.5 | 81 | 18.1 | 48.8 | mg/kg |
| 450 | Strontium | 1 | 100.00% | 60.0 | 60 | NA | 48.8 | mg/kg |
| 455 | Strontium | 1 | 0.00% | 16.0 | 16 | NA | 48.8 | mg/kg |
| 528 | Strontium | 1 | 100.00% | 97.0 | 97 | NA | 48.8 | mg/kg |
| 559 | Strontium | 12 | 8.33% | 24.5 | 60 | 15.4 | 48.8 | mg/kg |
| 701 | Strontium | 4 | 25.00% | 34.3 | 49 | 15.3 | 48.8 | mg/kg |
| 707 | Strontium | 20 | 0.00% | 16.7 | 37 | 6.69 | 48.8 | mg/kg |
| 712/713 | Strontium | 12 | 33.33% | 52.9 | 120 | 34.5 | 48.8 | mg/kg |
| 770 | Strontium | 2 | 100.00% | 60.0 | 71 | 15.6 | 48.8 | mg/kg |
| 771 | Strontium | 12 | 41.67% | 44.1 | 63.5 | 13.1 | 48.8 | mg/kg |
| 774 | Strontium | 4 | 75.00% | 56.8 | 89 | 22.6 | 48.8 | mg/kg |
| 776 | Strontium | 20 | 0.00% | 25.3 | 40 | 8.14 | 48.8 | mg/kg |
| 777 | Strontium | 25 | 16.00% | 30.2 | 110 | 22.2 | 48.8 | mg/kg |
| 778 | Strontium | 15 | 0.00% | 27.3 | 47 | 9.98 | 48.8 | mg/kg |
| 779 | Strontium | 3 | 0.00% | 23.0 | 28 | 5.00 | 48.8 | mg/kg |

[27] This column indicates those samples that were detected and greater than background. As a result, if this field shows 0% and a mean and maximum concentration are reported, the values represent those analytes detected but less than background.

| UBC | Analyte | Total Number of Samples | Detection Frequency > Background[27] | Mean | Maximum Concentration | Standard Deviation | Background Mean Plus 2SD | Unit |
|---|---|---|---|---|---|---|---|---|
| 865 | Strontium | 25 | 48.00% | 72.6 | 300 | 70.0 | 48.8 | mg/kg |
| 881 | Strontium | 25 | 24.00% | 39.9 | 132 | 24.6 | 48.8 | mg/kg |
| 883 | Strontium | 12 | 91.67% | 110 | 200 | 44.5 | 48.8 | mg/kg |
| 886 | Strontium | 23 | 47.83% | 75.0 | 178 | 51.8 | 48.8 | mg/kg |
| 889 | Strontium | 3 | 100.00% | 107 | 131 | 28.7 | 48.8 | mg/kg |
| 991 | Strontium | 10 | 40.00% | 73.8 | 250 | 76.1 | 48.8 | mg/kg |

NA = Not Applicable

### 2.1.18 Thallium

Thallium was not identified or discussed in building process information (CDH 1992; DOE 2004). Thallium has not been found associated in UBC sites (DOE 2004).

Thallium compounds were initially identified in the ChemRisk Task 1 report in inventory at RFETS (although no specific building was identified) (CDH 1991b). These chemicals appeared to have been used as laboratory standards or analytical testing materials because they were used in very small quantities. Based on the estimated quantity of these chemicals used, thallium was not carried forward as a material of concern for the ChemRisk process.

Small amounts of waste containing thallium as an underlying hazardous constituent have been generated from both laboratory and process buildings (Table 4 and Table 7).

Thallium was not identified above a RFCA AL requiring an accelerated action based on SAPs, SAP Addenda, or Closeout Reports for IHSSs and UBC sites.

In reviewing the thallium soil data beneath the slabs for UBC sites (Figure 18), the summary statistics presented in Table 25 were generated.

**Table 25 UBC Soil Summary Statistics for Thallium (mg/kg)**

| UBC | Analyte | Total Number of Samples | Detection Frequency > Background[28] | Mean | Maximum Concentration | Standard Deviation | Background Mean Plus 2SD | Unit |
|---|---|---|---|---|---|---|---|---|
| 122 | Thallium | 6 | 33.33% | 0.681 | 1.3 | 0.373 | 0.443 | mg/kg |
| 123 | Thallium | 0 | NA | NA | NA | NA | 0.443 | mg/kg |
| 331 | Thallium | 16 | 12.50% | 0.928 | 5.4 | 1.22 | 0.443 | mg/kg |
| 371 | Thallium | 1 | 0.00% | ND | ND | ND | 0.443 | mg/kg |
| 374 | Thallium | 3 | 33.33% | 0.445 | 0.91 | 0.403 | 0.443 | mg/kg |
| 439 | Thallium | 6 | 33.33% | 0.568 | 0.93 | 0.272 | 0.443 | mg/kg |
| 440 | Thallium | 10 | 60.00% | 0.821 | 1.2 | 0.324 | 0.443 | mg/kg |
| 441 | Thallium | 5 | 80.00% | 0.980 | 1.1 | 0.130 | 0.443 | mg/kg |
| 442 | Thallium | 11 | 0.00% | ND | ND | ND | 0.443 | mg/kg |
| 444 | Thallium | 39 | 41.03% | 0.838 | 2 | 0.479 | 0.443 | mg/kg |
| 445 | Thallium | 1 | 0.00% | ND | ND | ND | 0.443 | mg/kg |
| 447 | Thallium | 17 | 29.41% | 0.790 | 2.1 | 0.569 | 0.443 | mg/kg |

[28] This column indicates those samples that were detected and greater than background. As a result, if this field shows 0% and a mean and maximum concentration are reported, the values represent those analytes detected but less than background.

| UBC | Analyte | Total Number of Samples | Detection Frequency > Background[28] | Mean | Maximum Concentration | Standard Deviation | Background Mean Plus 2SD | Unit |
|---|---|---|---|---|---|---|---|---|
| 450 | Thallium | 1 | 0.00% | ND | ND | ND | 0.443 | mg/kg |
| 455 | Thallium | 1 | 0.00% | ND | ND | ND | 0.443 | mg/kg |
| 528 | Thallium | 1 | 100.00% | 1.80 | 1.8 | NA | 0.443 | mg/kg |
| 559 | Thallium | 12 | 16.67% | 0.596 | 1.4 | 0.353 | 0.443 | mg/kg |
| 701 | Thallium | 4 | 0.00% | ND | ND | ND | 0.443 | mg/kg |
| 707 | Thallium | 20 | 5.00% | 0.485 | 1.2 | 0.169 | 0.443 | mg/kg |
| 712/713 | Thallium | 11 | 0.00% | ND | ND | ND | 0.443 | mg/kg |
| 770 | Thallium | 2 | 0.00% | ND | ND | ND | 0.443 | mg/kg |
| 771 | Thallium | 13 | 23.08% | 0.379 | 1.2 | 0.287 | 0.443 | mg/kg |
| 774 | Thallium | 4 | 0.00% | 0.490 | 0.37 | 0.085 | 0.443 | mg/kg |
| 776 | Thallium | 20 | 15.00% | 0.583 | 1.4 | 0.300 | 0.443 | mg/kg |
| 777 | Thallium | 25 | 8.00% | 0.481 | 1.1 | 0.175 | 0.443 | mg/kg |
| 778 | Thallium | 15 | 6.67% | 0.510 | 1.3 | 0.219 | 0.443 | mg/kg |
| 779 | Thallium | 3 | 0.00% | ND | ND | ND | 0.443 | mg/kg |
| 865 | Thallium | 25 | 28.00% | 0.621 | 1.1 | 0.269 | 0.443 | mg/kg |
| 881 | Thallium | 25 | 0.00% | ND | ND | ND | 0.443 | mg/kg |
| 883 | Thallium | 12 | 66.67% | 1.62 | 5.1 | 1.25 | 0.443 | mg/kg |
| 886 | Thallium | 23 | 8.70% | 0.343 | 1 | 0.208 | 0.443 | mg/kg |
| 889 | Thallium | 3 | 0.00% | ND | ND | ND | 0.443 | mg/kg |
| 991 | Thallium | 10 | 0.00% | ND | ND | ND | 0.443 | mg/kg |

NA = Not Applicable ND = Not Detected

### 2.1.19 Vanadium

Pit construction in Building 707 generally used plutonium, uranium, beryllium, aluminum, and stainless steel (CDH 1992; DOE 2004). However, in some instances more exotic materials such as cadmium, vanadium, silver, and gold were used; however, the amounts were relatively minor compared to the primary five metals. The metallurgical operations in Building 865 (R&D) involved the development of alloys in the 1970s. Some of the metals employed in the alloying development included aluminum, copper, magnesium, molybdenum, niobium, platinum, stainless steel, tantalum, titanium, and vanadium. Vanadium was also identified as associated with metalworking in Building 444. In Building 447 materials handled included stainless steel, beryllium, aluminum, depleted uranium, and vanadium compounds.

The buildings identified above involved radiological operations and included extensive HEPA filtration systems. Any emissions from machining vanadium would have been collected on these filters prior to release from the buildings.

Vanadium compounds were initially identified in the ChemRisk Task 1 report in inventory at RFETS (CDH 1991b). However, based on the estimated quantity of these chemicals used (typically less than 1 kg with the exception of a pentoxide at 12 kg in 1974 and less than 1 kg in 1988) vanadium was not carried forward as a material of concern for the ChemRisk process.

Waste containing vanadium as an underlying hazardous constituent was generated from Buildings 559 and 881 (Table 4 and Table 7).

Vanadium was not identified above a RFCA AL requiring an accelerated action based on SAPs, SAP Addenda, or Closeout Reports for IHSSs and UBC sites.

In reviewing the vanadium soil data beneath the slabs for UBC sites (Figure 19), the summary statistics presented in Table 26 were generated.

**Table 26 UBC Soil Summary Statistics for Vanadium (mg/kg)**

| UBC | Analyte | Total Number of Samples | Detection Frequency > Background[29] | Mean | Maximum Concentration | Standard Deviation | Background Mean Plus 2SD | Unit |
|---|---|---|---|---|---|---|---|---|
| 122 | Vanadium | 6 | 0.00% | 24.2 | 42 | 13.3 | 43.1 | mg/kg |
| 123 | Vanadium | 0 | NA | NA | NA | NA | 43.1 | mg/kg |
| 331 | Vanadium | 16 | 6.25% | 30.8 | 50 | 7.43 | 43.1 | mg/kg |
| 371 | Vanadium | 1 | 0.00% | 12.0 | 12 | NA | 43.1 | mg/kg |
| 374 | Vanadium | 3 | 0.00% | 16.9 | 28.7 | 10.5 | 43.1 | mg/kg |
| 439 | Vanadium | 6 | 0.00% | 17.8 | 35.5 | 9.20 | 43.1 | mg/kg |
| 440 | Vanadium | 10 | 0.00% | 26.1 | 39 | 8.76 | 43.1 | mg/kg |
| 441 | Vanadium | 5 | 20.00% | 39.2 | 52 | 8.07 | 43.1 | mg/kg |
| 442 | Vanadium | 11 | 18.18% | 34.8 | 46.3 | 8.75 | 43.1 | mg/kg |
| 444 | Vanadium | 39 | 7.69% | 33.3 | 51 | 8.36 | 43.1 | mg/kg |
| 445 | Vanadium | 1 | 100.00% | 54.0 | 54 | NA | 43.1 | mg/kg |
| 447 | Vanadium | 17 | 17.65% | 39.7 | 52 | 8.59 | 43.1 | mg/kg |
| 450 | Vanadium | 1 | 0.00% | 31.0 | 31 | NA | 43.1 | mg/kg |
| 455 | Vanadium | 1 | 0.00% | 21.0 | 21 | NA | 43.1 | mg/kg |
| 528 | Vanadium | 1 | 100.00% | 78.0 | 78 | NA | 43.1 | mg/kg |
| 559 | Vanadium | 12 | 0.00% | 24.0 | 42 | 8.98 | 43.1 | mg/kg |
| 701 | Vanadium | 4 | 0.00% | 35.5 | 43 | 8.35 | 43.1 | mg/kg |
| 707 | Vanadium | 20 | 0.00% | 15.1 | 26 | 3.98 | 43.1 | mg/kg |
| 712/713 | Vanadium | 12 | 16.67% | 32.6 | 74 | 17.4 | 43.1 | mg/kg |
| 770 | Vanadium | 2 | 0.00% | 35.5 | 39 | 4.95 | 43.1 | mg/kg |
| 771 | Vanadium | 12 | 8.33% | 30.2 | 48 | 8.76 | 43.1 | mg/kg |
| 774 | Vanadium | 4 | 0.00% | 34.8 | 41 | 4.19 | 43.1 | mg/kg |
| 776 | Vanadium | 20 | 15.00% | 29.0 | 51 | 12.2 | 43.1 | mg/kg |
| 777 | Vanadium | 25 | 8.00% | 25.8 | 56 | 11.3 | 43.1 | mg/kg |
| 778 | Vanadium | 15 | 13.33% | 26.2 | 44 | 9.96 | 43.1 | mg/kg |
| 779 | Vanadium | 3 | 33.33% | 39.0 | 53 | 14.5 | 43.1 | mg/kg |
| 865 | Vanadium | 25 | 8.00% | 27.8 | 46 | 9.02 | 43.1 | mg/kg |
| 881 | Vanadium | 25 | 4.00% | 32.8 | 49.3 | 6.66 | 43.1 | mg/kg |
| 883 | Vanadium | 12 | 66.67% | 47.3 | 64 | 15.0 | 43.1 | mg/kg |
| 886 | Vanadium | 23 | 4.35% | 24.7 | 64 | 10.9 | 43.1 | mg/kg |
| 889 | Vanadium | 3 | 66.67% | 59.1 | 76.9 | 22.7 | 43.1 | mg/kg |
| 991 | Vanadium | 10 | 50.00% | 39.7 | 70 | 21.1 | 43.1 | mg/kg |

NA = Not Applicable

[29] This column indicates those samples that were detected and greater than background. As a result, if this field shows 0% and a mean and maximum concentration are reported, the values represent those analytes detected but less than background.

### 2.1.20 Zinc

Zinc was not identified or discussed in building process information (CDH 1992; DOE 2004). Zinc has not been found associated with UBC sites (DOE 2004).

Zinc was initially identified in the ChemRisk Task 1 report in inventory at RFETS (although no specific building was identified) (CDH 1991b), in the form of acetate, bromide, carbonate, chloride, cyanide, fluoride, metal powder, nitrate, oxide, sulfide, and sulfate. Based on the relative toxicity of the material, how the material might have been released into the environment, and/or the likelihood for transport off-site, zinc was not carried forward as a material of concern for the ChemRisk process.

Waste containing zinc as an underlying hazardous constituent was generated from Building 881 (Table 4 and Table 7).

Zinc was not identified above a RFCA AL requiring an accelerated action based on SAPs, SAP Addenda, or Closeout Reports for IHSSs and UBC sites.

Zinc orthophosphate was added to the drinking water system from 2002 to system closure to prevent copper and lead corrosion.

In reviewing the zinc soil data beneath the slab for UBC sites (Figure 20), the summary statistics presented in Table 27 were generated.

**Table 27 UBC Soil Summary Statistics for Zinc (mg/kg)**

| UBC | Analyte | Total Number of Samples | Detection Frequency > Background[30] | Mean | Maximum Concentration | Standard Deviation | Background Mean Plus 2SD | Unit |
|---|---|---|---|---|---|---|---|---|
| 122 | Zinc | 6 | 0.00% | 28.3 | 45 | 11.7 | 74.2 | mg/kg |
| 123 | Zinc | 0 | NA | NA | NA | NA | 74.2 | mg/kg |
| 331 | Zinc | 16 | 6.25% | 35.6 | 190 | 42.3 | 74.2 | mg/kg |
| 371 | Zinc | 1 | 0.00% | 14.0 | 14 | NA | 74.2 | mg/kg |
| 374 | Zinc | 3 | 0.00% | 27.2 | 47.6 | 17.9 | 74.2 | mg/kg |
| 439 | Zinc | 6 | 16.67% | 59.0 | 183 | 60.8 | 74.2 | mg/kg |
| 440 | Zinc | 10 | 0.00% | 33.7 | 45 | 9.31 | 74.2 | mg/kg |
| 441 | Zinc | 5 | 20.00% | 47.6 | 120 | 40.6 | 74.2 | mg/kg |
| 442 | Zinc | 11 | 0.00% | 32.4 | 69.6 | 15.1 | 74.2 | mg/kg |
| 444 | Zinc | 39 | 2.56% | 34.6 | 130 | 19.1 | 74.2 | mg/kg |
| 445 | Zinc | 1 | 0.00% | 28.0 | 28 | NA | 74.2 | mg/kg |
| 447 | Zinc | 17 | 11.76% | 48.5 | 270 | 62.4 | 74.2 | mg/kg |
| 450 | Zinc | 1 | 0.00% | 25.0 | 25 | NA | 74.2 | mg/kg |
| 455 | Zinc | 1 | 100.00% | 80.0 | 80 | NA | 74.2 | mg/kg |
| 528 | Zinc | 1 | 0.00% | 42.0 | 42 | NA | 74.2 | mg/kg |
| 559 | Zinc | 12 | 0.00% | 21.2 | 37 | 6.83 | 74.2 | mg/kg |
| 701 | Zinc | 4 | 0.00% | 51.5 | 69 | 15.4 | 74.2 | mg/kg |
| 707 | Zinc | 20 | 0.00% | 28.0 | 45 | 8.38 | 74.2 | mg/kg |

[30] This column indicates those samples that were detected and greater than background. As a result, if this field shows 0% and a mean and maximum concentration are reported, the values represent those analytes detected but less than background.

| UBC | Analyte | Total Number of Samples | Detection Frequency > Background[30] | Mean | Maximum Concentration | Standard Deviation | Background Mean Plus 2SD | Unit |
|---|---|---|---|---|---|---|---|---|
| 712/713 | Zinc | 12 | 33.33% | 112 | 410 | 116 | 74.2 | mg/kg |
| 770 | Zinc | 2 | 0.00% | 49.0 | 64 | 21.2 | 74.2 | mg/kg |
| 771 | Zinc | 12 | 16.67% | 53.2 | 93.6 | 20.7 | 74.2 | mg/kg |
| 774 | Zinc | 4 | 0.00% | 48.0 | 59 | 7.87 | 74.2 | mg/kg |
| 776 | Zinc | 20 | 0.00% | 35.2 | 60 | 9.59 | 74.2 | mg/kg |
| 777 | Zinc | 25 | 4.00% | 39.5 | 160 | 28.8 | 74.2 | mg/kg |
| 778 | Zinc | 15 | 0.00% | 33.1 | 56 | 10.0 | 74.2 | mg/kg |
| 779 | Zinc | 3 | 0.00% | 26.7 | 29 | 2.52 | 74.2 | mg/kg |
| 865 | Zinc | 25 | 8.00% | 49.9 | 180 | 31.0 | 74.2 | mg/kg |
| 881 | Zinc | 25 | 0.00% | 35.1 | 72.7 | 16.2 | 74.2 | mg/kg |
| 883 | Zinc | 12 | 0.00% | 45.8 | 63 | 12.2 | 74.2 | mg/kg |
| 886 | Zinc | 23 | 4.35% | 31.4 | 124 | 22.4 | 74.2 | mg/kg |
| 889 | Zinc | 3 | 0.00% | 48.2 | 66.6 | 18.5 | 74.2 | mg/kg |
| 991 | Zinc | 10 | 0.00% | 41.1 | 74 | 16.4 | 74.2 | mg/kg |

NA = Not Applicable

## 2.2 Radionuclides

A total of 4 radionuclide AOIs have been identified in media based on the nature and extent evaluations. These radionuclides are discussed in the following sections.

### 2.2.1 Cesium-137

The ChemRisk Task 1 Report identified cesium-137 as a radionuclide used for research, analytical, and calibration activities (for example, sealed and plated sources) (CDH 1991a). Based on the limited quantity of this material, cesium-137 was not carried forward through the ChemRisk process (CDH 1991b). In addition, the only cesium-137 waste generated at this site was identified as sealed sources (based on WEMS and WSRIC) from Buildings707, 776/777, and 991.

In addition, according to the Task 2 ChemRisk Report, environmental sampling data indicate the presence of detectable quantities of other radionuclides characteristic of nuclear weapons fallout, such as strontium-89 and 90, zirconium-95, cesium-137, and cerium-144, which were also found in environmental samples from 1970 through 1981. Detection of these compounds is consistent with the presence of fission products from worldwide fallout, and the detected levels are typical of other sites sampled in the western United States (CDH 1991b).

Based on a study of off-site areas surrounding RFETS, the Citizen's Environmental Sampling Committee (CESC) conducted soil and sediment sampling in 1993 and 1994, and analyzed for plutonium (plutonium-238 and plutonium-239/240), americium (americium-241), cesium (cesium-137), strontium (strontium -90), and uranium (uranium-235 and uranium-238) (CESC 1996). Background levels of cesium-137 and stronium-90 were detected in some soil samples. This report noted that cesium-137 and strontium-90 are generally associated with nuclear chain reactions. Although the Rocky Flats Plant never operated a full-scale nuclear reactor, they did perform criticality experiments. This report concluded that "no evidence has been found to suggest that cesium-137 or strontium-90 were released during the operational period of the Rocky Flats Plant".

Based on the history of usage and historical conclusions made regarding cesium-137, only two surface soil samples were collected during accelerated actions (one east of building 454 and one south of building 447), and both were below background (1.69 pCi/g). As a result, no summary statistics or figures were generated.

### 2.2.2 Radium

The ChemRisk Task 1 Report identified radium-226 as a radionuclide used for research, analytical, and calibration activities (for example, sealed and plated sources) (CDH 1991a). Based on the limited quantity of this material, radium-226 was not carried forward through the ChemRisk process (CDH 1991b). In addition, the only radium-226 waste generated at RFETS was identified as sealed sources (based on WEMS and WSRIC).

Radium-226 waste (sealed sources) was generated from Buildings 707, and 776/777.

The ChemRisk Task 1 Report did not identify radium-228 as a radionuclide used at the Rocky Flats Plant (CDH 1991a) and no radium-228 waste was reported to have been generated.

Radium-226 soil data around buildings and UBC sites are presented on Figure 21. Because there were no UBC soil data for radium-226, no summary statistics were generated.

Radium-228 soil data around buildings and UBC sites are presented on Figure 22. Because there were no UBC soil data for radium-228, no summary statistics were generated. For additional information regarding radium-228 see Section 2.2.4.

### 2.2.3 Strontium-89/90

The ChemRisk Task 1 Report identified stronium-89/90 as a radionuclide used for research, analytical, and calibration activities (for example, sealed sources, plated sources, liquid sources, and analytical stock solutions (CDH 1991a). Based on the limited quantity of this material, strontium-89/90 was not carried forward through the ChemRisk process (CDH 1991b).

In addition, according to the ChemRisk Task 2 Report, environmental sampling data indicate the presence of detectable quantities of other radionuclides characteristic of nuclear weapons fallout, such as strontium-89 and 90, zirconium-95, cesium-137, and cerium-144, which were also found in environmental samples from 1970 through 1981. Detection of these compounds is consistent with the presence of fission products from worldwide fallout, and the detected levels are typical of other sites sampled in the western United States (CDH 1991b).

Based on a study of off-site areas surrounding Rocky Flats, the CESC conducted soil and sediment sampling in 1993 and 1994 and analyzed for plutonium (Pu-238 and Pu-239/240), americium (americium-241), cesium (cesium-137), strontium (strontium-90), and uranium (uranium-235 and uranium-238) (CESC 1996). Background levels of cesium-137 and strontium-90 were detected in some soil samples. This report noted that cesium-137 and strontium-90 are generally associated with nuclear chain reactions. Although the Rocky Flats Plant never operated a full-scale nuclear reactor, they did perform criticality experiments. This report concluded that "no evidence has been found to suggest that cesium-137 or strontium-90 were released during the operational period of the Rocky Flats Plant".

Based on the history of usage and historical conclusions made regarding strontium-89/90, only three soil samples were collected during accelerated actions for UBC 123. These results indicated that strontium 89/90 was not detected. As a result, no summary statistics or figure was generated.

### 2.2.4 Thorium-232

Thorium-232 has been identified in this review because the AOI radium-228 is in the thorium-232 decay chain.

Thorium has been used in several ways at RFETS since 1952. The major use was fabrication of metal parts from natural thorium and thorium alloys (Building 881). The compounds have been used in analytical procedures and development programs (Building 771). Although amounts were small, applications were numerous. Over the period from 1952 to 1976, which saw the majority of thorium applications at Rocky Flats, the quantity of thorium that was present varied from none to approximately 238 kg in any one month (CDPHE 1994).

A project in Building 881 involved thorium-232 production over several years in the late 1950s to early 1960s (CDH 1992). There were very tight controls, and thorium went through the same processes as enriched uranium; however, most was sent to Savannah River, South Carolina or Oak Ridge, Tennessee for recovery.

According to the March 1994 Task 5 Report, a large fraction of the thorium material discarded (that is, Normal Operational Loss) would likely have been in solid wastes or particulates trapped by ventilation exhaust filters, given that the primary use of Rocky Flats' thorium was for metalworking processes (CDPHE 1994). This report concludes that it is likely that less than 32 kg of thorium would have been released in airborne effluents from the Rocky Flats Plant over its operational history. In addition, criticality experiments were not likely to have been a source of significant releases of radionuclides from the Plant.

The information reviewed in the ChemRisk reports concludes that thorium-232 has not been a significant component of airborne effluents from the Rocky Flats Plant and was not used in significant quantities relative to other production radionuclides (CDH 1991b). Because thorium would most likely have been emitted in particulate form, and thorium-232 emits an alpha particle with each decay, thorium emissions are reflected in results of measurements of total long-lived alpha radioactivity that were performed since the early 1950s. Thorium operations have been insignificant relative to the primary production activities centered around plutonium and uranium, and little data exist to support the quantification of release. Therefore, efforts to attribute a portion of total long-lived alpha activity measurements to thorium-232 were not made in the ChemRisk reports (CDPHE 1994). In addition, because of the apparent diminishing of applications of thorium compounds since the 1970s, development of source term estimates for thorium-232 during the 1970s and 1980s was not considered warranted in the ChemRisk reports.

Based on the history of usage and historical conclusions made regarding thorium-232, no soil samples were collected during accelerated actions. As a result, no summary statistics or figure for thorium-232 was generated.

## 3.0 SUMMARY

Historical knowledge indicates there is no inventory remaining at RFETS for these AOIs, and any potential "source term" remaining is expected to be low, because the release potential was also low.

Table 28 provides a summary of information available for each AOI as discussed in previous sections.

## 4.0 REFERENCES

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CESC, 1996, Soil and Sediment Study of Off-Site Areas Surrounding the Rocky Flats Nuclear Weapons Plant, Executive Summary, Citizen's Environmental Sampling Committee, September. Found at http://www.cdphe.state.co.us/rf/soilsedstudy.htm.

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DOE, 2003b, Final Proposed Action Memorandum for IHSS 101 and RCRA Closure of the RFETS Solar Evaporation Ponds, April. Approved by CDPHE on May 22, 2003.

DOE, 2004a, Industrial Area and Buffer Zone Sampling and Analysis Plan, Rocky Flats Environmental Technology Site, Golden, Colorado, May.

DOE, 2004b, Final Comprehensive Risk Assessment Work Plan and Methodology, September.

**Table 28 Summary of AOI Information**

| AOIs | Examples of Materials Used | Inventory in Buildings | Total Quantity in Inventory (kg) [a] | Waste Generated in Buildings | Spills/ Releases Within Buildings[b] | IHSS, PAC or UBC Requiring an Accelerated Action | UBC Mean Data Results > Background Mean + 2 Standard Deviations | UBC Mean Data Results ≤ Background Mean + 2 Standard Deviations |
|---|---|---|---|---|---|---|---|---|
| Aluminum | Aluminum metal, nitrate, silicate, and oxide. | 444, 447, 707, 771, 779, 883, and 865 | 7,700 | 371, 559, 707, 778, 779, and 887 | None identified | None | 441, 442, 445, 447, 450, 528, 712/713, 774, and 779 | 122, 123, 331, 371, 374, 439, 440, 444, 455, 559, 701, 707, 770, 771, 776, 777, 778, 865, 881, 883, 886, 889, and 991 |
| Antimony | Acid containing antimony, antimony iodide, oxide, pentachloride, powder, trioxide, and trichloride. | None identified | 8 | 559[c] | None identified | None | 712/713 | 122, 123, 331, 371, 374, 439, 440, 441, 442, 444, 445, 447, 450, 455, 528, 559, 701, 707, 770, 771,774, 776, 777, 778, 779, 865, 881, 883, 886, 889, and 991 |
| Arsenic | Arsenic acid, iodide, metals, pentoxide, solution 3103, trioxide, and oxide. | None identified | 5 | 371, 374, 460, 559, 707, 771, 774, 776/777, 778, 779, 881, 883, 865, 887, and 889 | None identified | PAC 700-137, outside Building 707, and PAC SE-1602 | 771 | 122, 123, 331, 371, 374, 439, 440, 441, 442, 444, 445, 447, 450, 455, 528, 559, 701, 707, 712/713, 770, 774, 776, 777, 778, 779, 865, 881, 883, 886, 889, and 991 |
| Barium | Barium acetate, chloride, fluoride, metal, nitrate, and sulfate. | None identified | 33 | 371, 374, 439, 442, 444, 559, 707, 771, 774, 776/777, 778, 779, 881, 883, 865, 886, and 887 | None identified | None | 528 and 774 | 122, 123, 331, 371, 374, 439, 440, 441, 442, 444, 445, 447, 450, 455, 559, 701, 707, 712/713, 770, 771, 776, 777, 778, 779, 865, 881, 883, 886, 889, and 991 |
| Cadmium | Cadmium acetate, chloride, iodide, metal, nitrate, and sulfate | 123, 444, 528, 559, 561, 707, 731, 774, | 44 | 122, 123, 125, 331, 371, 374, 439, 440, | 123, 444, 528, 559, 707, 731, 771, and 774 | None | None | 122, 123, 331, 371, 374, 439, 440, 441, 442, 444, 445, 447, 450, 455, 528, 559, |

| AOIs | Examples of Materials Used | Inventory in Buildings | Total Quantity in Inventory (kg) [a] | Waste Generated in Buildings | Spills/ Releases Within Buildings[b] | IHSS, PAC or UBC Requiring an Accelerated Action | UBC Mean Data Results > Background Mean + 2 Standard Deviations | UBC Mean Data Results ≤ Background Mean + 2 Standard Deviations |
|---|---|---|---|---|---|---|---|---|
| | | 771, 776/777, 881, and 883 | | 441, 442, 444, 447, 460, 559, 701, 707, 771, 774, 776, 777, 778, 779, 865, 881, 883, 886, 887, and 991 | | | | 701, 707, 712/713, 770, 771, 774, 776, 777, 778, 779, 865, 881, 883, 886, 889, and 991 |
| Chromium (total) | Chromium boride, chloride, metal, nitrate, oxide, sulfate, and trioxide. | 123, 371, 374, 444, 460, 528, 559, 561, 712/713, 731, 774, 776/777, and 779 | 734 | 122, 123, 331, 371, 374, 439, 440, 441, 444, 447, 460, 559, 701, 707, 771, 774, 776, 777, 778, 779, 865, 881, 883, 886, 887, and 991 | 123, 371, 374, 444, 528, 559, 707, 731, and 774 | PAC 500-158 | 331, 440, 441, 444, 445, 447, 528, 701, 712/713, 770, 771, 774, 776, 777, 779, and 881 | 122, 123, 371, 374, 439, 442, 450, 455, 559, 707, 712/713, 778, 865, 883, 886, 889, and 991 |
| Cobalt | Cobalt (metal, powder, wire, and foil), chloride, nitrate, oxide, and sulfate. | None identified | 25 | None identified | None identified | None | 444, 450, 776, 777, 778, 779, 881, and 991 | 122, 123, 331, 371, 374, 439, 440, 441, 442, 445, 447, 455, 528, 559, 701, 707, 712/713, 770, 771, 774, 865, 883, 886, and 889 |
| Copper | Copper metal, cyanide and sulfate. | 444, 779, 881, 883, and 865 | 27 | 559 and 881 | None identified | None | 331, 374, 440, 444, 447, 450, 455, 528, 559, 701, 707, 712/713, 770, 771, 774, 776, 777, 778, 779, 865, 881, 883, 886, 889, and 991 | 122, 123, 371, 439, 441, 442, and 445 |
| Iron | Ferric ammonium | 371, 444, | 978 | None | None identified | None | 445, 447, 712/713, | 122, 123, 331, 371, |

| AOIs | Examples of Materials Used | Inventory in Buildings | Total Quantity in Inventory (kg) [a] | Waste Generated in Buildings | Spills/ Releases Within Buildings[b] | IHSS, PAC or UBC Requiring an Accelerated Action | UBC Mean Data Results > Background Mean + 2 Standard Deviations | UBC Mean Data Results ≤ Background Mean + 2 Standard Deviations |
|---|---|---|---|---|---|---|---|---|
| | oxalate, nitrate, sulfide, and ammonium sulfate. | 445, 450, and 455 | | identified | | | 779, 883, and 889 | 374, 439, 440, 441, 442, 444, 450, 455, 528, 559, 701, 707, 770, 771, 774, 776, 777, 778, 865, 881, 886, and 991 |
| Lead | Lead acetate, chloride, iodide, metal, nitrate, oxide and powder. | 123, 371, 374, 528, 559, 701, 707, 731, 774, 771, and 776/777 | 140 | 122, 123, 125, 331, 371, 374, 439, 440, 442, 447, 460, 559, 701, 707, 770, 771, 774, 776/777, 778, 779, 865, 881, 883, 886, 887, 889, and 991 | 123, 371, 374, 528, 559, 707, 731,771, and 774 | UBC 123, PAC 400-122, PAC NW-1505, and PAC SE-1602 | 447 | 122, 123, 331, 371, 374, 439, 440, 441, 442, 444, 445, 450, 455, 528, 559, 701, 707, 712/713, 770, 771, 774, 776, 777, 778, 779, 865, 881, 883, 886, 889, and 991 |
| Lithium | Lithium aluminum hydride, chloride, chromate, fluoride, metal, nitrate, and sulfate. | 559, 707, 776/777, and 881 | 300 | 125, 371, 444, 460, 559, 771, 778, 881, and 883 | 559 and 707 | None | 441, 445, 447, 712/713, 774, 776, 779, 881, 883, | 122, 123, 331, 371, 374, 439, 440, 442, 444, 450, 455, 528, 559, 701, 707, 770, 771, 777, 778, 865, 886, 889, and 991 |
| Manganese | Manganese carbonate, chips, dioxide, flake, II oxide, metal, powder, chloride, nitrate and sulfate. | None identified | 6 | None identified | None identified | None | 883 and 889 | 122, 123, 331, 371, 374, 439, 440, 441, 442, 444, 445, 447, 450, 455, 528, 559, 701, 707, 712/713, 770, 771, 774, 776, 777, 778, 779, 865, 881, 886, and 991 |
| Mercury | Mercuric acetate, chloride, mercuric oxide. | | 10 | | | | | |

| AOIs | Examples of Materials Used | Inventory in Buildings | Total Quantity in Inventory (kg) [a] | Waste Generated in Buildings | Spills/ Releases Within Buildings[b] | IHSS, PAC or UBC Requiring an Accelerated Action | UBC Mean Data Results > Background Mean + 2 Standard Deviations | UBC Mean Data Results ≤ Background Mean + 2 Standard Deviations |
|---|---|---|---|---|---|---|---|---|
| Molybdenum | Molybdenum boride, carbide, disulfide, metal, metal powder, silicide, and trioxide. | 444, 771, 774, 776/777, 779, and 881 | 13 | 559 | None identified | None | 712/713 and 883 | 122, 123, 331, 371, 374, 439, 440, 441, 442, 444, 445, 447, 450, 455, 528, 559, 701, 707, 770, 771, 774, 776, 777, 778, 779, 865, 881, 886, 889, and 991 |
| Nickel | Nickel acetate, chloride, cyanide, metal, metal powder, nitrate, oxide and sulfate | 371, 374, 444, 771, 774, 776/777, 779, 881, and 991 | 126 | 122, 125, 331, 371, 374, 439, 442, 444, 559, 701, 707, 771, 774, 776/777, 778, 779, 865, 881, 883,886, and 991 | 371, 374, 444, 771, and 774 | None | 331, 441, 445, 447, 450, 528, 701, 712/713, 770, 771, 777, 779, 881, 883, and 889 | 122, 123, 371, 374, 439, 440, 442, 444, 447, 455, 559, 707, 774, 776, 778, 865, 886, and 991 |
| Selenium | Selenium dioxide, oxide, pellets, and powder | None identified | 1 | 371, 374, 439, 441, 444, 559, 707, 771, 774, 776/777, 779, 865, 881, 883, and 887 | None identified | None | 445 and 450 | 122, 123, 331, 371, 374, 439, 440, 441, 442, 444, 447, 455, 528, 559, 701, 707, 712/713, 770, 771, 774, 776, 777, 778, 779, 865, 881, 883, 886, 889, and 991 |
| Strontium | Strontium carbonate, chloride, fluoride, nitrate, oxide, sulfide and zirconate | None identified | 8 | None identified | None identified | None | 450, 528, 712/713, 770, 774, 865, 883, 886, 889, and 991 | 122, 123, 331, 371, 374, 439, 440, 441, 442, 444, 445, 447, 455, 559, 701, 707, 771, 776, 777, 778, 779, and 881 |
| Thallium | Thallium | None identified | <1 | 559, 707, 771, 779, and 881 | None identified | None | 122, 331, 374, 439, 440, 441, 444, 447, 528, 559, 707, 774, | 123, 371, 442, 445, 450, 455, 701, 712/713, 770, 771, |

| AOIs | Examples of Materials Used | Inventory in Buildings | Total Quantity in Inventory (kg) [a] | Waste Generated in Buildings | Spills/ Releases Within Buildings[b] | IHSS, PAC or UBC Requiring an Accelerated Action | UBC Mean Data Results > Background Mean + 2 Standard Deviations | UBC Mean Data Results ≤ Background Mean + 2 Standard Deviations |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | 776, 777, 778, 865, 883, and 886 | 779, 881, 889, and 991 |
| Vanadium | Vanadium carbide, metal, nitride, pentoxide and sulfate | 444, 447, 707, 779, 865, 881, 883, | 4 | 559 and 881 | None identified | None | 445, 528, 883, and 889 | 122, 123, 331, 371, 374, 439, 440, 441, 442, 444, 447, 450, 455, 559, 701, 707, 712/713, 770, 771, 774, 776, 777, 778, 779, 865, 881, 886, and 991 |
| Zinc | Zinc acetate, bromide, carbonate, chloride, chromate primer, cyanide, fluoride, metal powder, mossy, nitrate, oxide and sulfate | None identified | 86 | 881 | None identified | None | 455 | 122, 123, 331, 371, 374, 439, 440, 441, 442, 444, 445, 447, 450, 528, 559, 701, 707, 712/713, 770, 771, 774, 776, 777, 778, 779, 865, 881, 883, 886, 889, and 991 |
| Cesium-137 | Sealed and plated sources | 886 | No quantity specified | 707, 776/777, and 991 | None identified | None | All samples collected were below background | NA |
| Radium-226 | Sealed and plated sources | None identified | No quantity specified | 707 and 776/777 | None identified | None | NA | NA |
| Radium-228 (Thorium-232) | Radium-228 was not identified in inventory at RFETS. Thorium-232 was used | 771 and 881 | No quantity specified | 881 | None identified | None | NA | NA |
| Strontium-89/90 | Sealed, plated and liquid sources, and analytical stock solutions | 779 | No quantity specified | 707 and 991 | None identified | None | All samples collected were not detected | NA |

NA = Not Applicable because data was not collected.

[a] Based on a 1988 inventory in the ChemRisk Task One Report (CDH 1991a)

[b] No spills or releases of these AOIs occurred within a building that required an action prior to demolition, based on sampling and analysis results.

[c] Antimony was identified as an underlying hazardous constituent in a waste from this building.

DOE, 2004c, Closeout Report for IHSS Group 500-2, IHSS 500-158 Radioactive Site-Building 551, June. Approved by CDPHE on June 18, 2004.

DOE, 2005a, Background Data Summary Tables Attachment 2, Data Description and Evaluation Volume 2 of 15, Appendix A Comprehensive Risk Assessment of the Draft Remedial Investigation/Feasibility Study Report, September.

DOE, 2005b, Closeout Report for IHSS Group 900-11, PAC SE-1602 East Firing Range and Target Area, March. Approved by EPA, Region VIII on February 8, 2005.

KH, 1998, Building 771/774 Cluster Closure Project RLCR, Rev. 2, (Administrative Record # B771-A-000119), Kaiser-Hill Company, L.L.C., Rocky Flats Environmental Technology Site, Golden, Colorado, August 8.

RFO, 1993, ORPS Occurrence Report Number: RFO--KHLL-371OPS-2003-0019, Rocky Flats Environmental Technology Site, Golden, Colorado, June 30.

RFO, 1998, ORPS Occurrence Report Number: RFO--KHLL-LIQWASTE-1998-0002, Rocky Flats Environmental Technology Site, Golden, Colorado, June 9.

RFO, 2002, ORPS Occurrence Report Number: RFO--KHLL-374OPS-2002-0004, Rocky Flats Environmental Technology Site, Golden, Colorado, November 25.

These occurrence reports were taken from the RFETS database Occurrence Reporting and Processing System (ORPS), which identified emergencies from 1991 to site closure.

Occurrence Report Number: RFO--KHLL-371OPS-2003-0019

On June 30, 1993 there was a sprinkler head malfunction in Room 3189 of Building 371 (radiological material area [not a contamination area or a radiological buffer area]), resulting in the release of fire water that ran into the hallway and into rooms 3187 A & B and 33185, eventually running onto Dock 18T and onto the ground north of Building 374 towards the outside storm drain. Fire department personnel began diverting water away from the storm drain. Approximately 6,000 gallons of water was released. It was collected and sampled and determined to be clean and approved for release to the storm drain system. (per emergency reporting system)

Impact on Environment, Safety, and Health: Radiological surveys and samples from monitoring equipment verified that this event caused no release of radiological materials. The environment and the health and safety of the public and plant personnel were not threatened.

Occurrence Report Number: RFO--KHLL-LIQWASTE-1998-0002

On June 9, 1998, at 1030 hours, approximately 1 gallon of a dark green liquid was discovered on Dock 8 of Buildings 371/374. Building 374 Environmental Operations and Radiological Operations personnel were contacted to investigate the substance. The substance was determined to be phosphoric acid contaminated with depleted uranium. The phosphoric acid apparently came from the drain pipe for Tank D-843. Radiological surveys taken indicated levels up to 3,000 direct counts per minute of alpha contamination. Incident Command was immediately established by the Building 371 Shift Manager. The RFETS Shift Superintendent responded and assumed command over the incident and declared an Operational Emergency at the Alert-Star level. This resulted in the precautionary activation of the Emergency Operations Center.

Tank D-843 had been filled with the phosphoric acid solution to the point that the high-level alarm had been actuated since 1991. The trigger for this event was the emergency generator test conducted on June 8, 1998, which de-energized the vent scrubber system, a vacuum system designed to remove fumes above the acid in the tank. The tank had become completely filled with liquid over the years and, consequently, the vacuum of the vent scrubber had drawn liquid up into the vent line. When the vent scrubber was de-energized, this vacuum was lost. Liquid in the dock drain line (the only input line to the tank), which had also become full, was then forced out onto the dock.

Impact on Environment, Safety, and Health: Although radioactive/toxic material was spilled in an undesirable location, it was determined that there was no impact on the environment, or on the health or safety of workers or the public.

RFO 2002 Occurrence Report Number: RFO--KHLL-374OPS-2002-0004

On November 25, 2002, there was a spill of low-level mixed waste from the RCRA-regulated Tank T231A (located south of Buildings 371/374) sludge removal operation. The spill occurred during a compressed air blow down of the 4-inch hose line between the pump and the centrifuge following completion of the sludge removal operations. The purpose of the system blow down was to empty the line of sludge prior to freezing weather conditions. During the blow down of the system the 4-inch line separated from its connection near the centrifuge causing the spill condition.

The spill exceeded the reportable quantity (10 pounds) for an F-listed waste. The majority of the waste was released inside the secondary containment area for the tank. Approximately 1 to 5 gallons (8 to 42 pounds) of waste was released outside the secondary containment over an area of approximately 600 square feet. Approximately 10 to 25 gallons (83 to 210 pounds) of waste was released inside of secondary containment over an area of approximately 200 square feet.

The spill was contained and the highest reported contamination levels were up to 750 disintegrations per minute per 100 square centimeters (dpm/100 $cm^2$) both inside and outside the secondary containment. The spill did not contain any detectable levels of beryllium. However, original sampling data from the 231A tank indicated levels of 0.2 to 0.3 micrograms per liter (ug/liter) of beryllium. Therefore, containment was established and recovery actions were developed for cleanup operations.

The spill was immediately contained and a Recovery Plan was initiated for cleanup operations. The Colorado Department of Public Health and Environment (CDPHE) was notified of the spill and the Recovery Actions that were initiated.

Impact on Environment, Safety, and Health: The assessment of actual or potential hazards to human health or the environment was determined to be minimal. The RCRA Contingency Plan was implemented due to exceeding a reportable quantity for an F-listed waste (that is, 10 pounds). However, the analytical results of the sludge samples indicated the actual levels of contamination of concern were very low and posed a minimal risk to the environment. The analytical results for all of the RCRA-regulated metals were well below the regulatory limits, with cadmium results being the highest at 104 micrograms per liter (μg/L) (parts per billion). The radiological test results indicated all isotopes tested for were in the range of picocuries per gram concentrations, with the isotope plutonium- 241 having the highest activity at 1,808 picocuries per gram (pCi/g). The highest contamination levels found during the initial release response were in the range of 100 to 600 dpm/100 $cm^2$.


# Figure 1

## Aluminum Soil Results Greater Than Background Mean + 2 Standard Deviations or WRW PRG

## KEY

- Constituent: > or = 10xPRG
- Constituent: > or = PRG and < 10xPRG
- Constituent: > Background Mean + 2 Standard Deviations and < PRG
- Building - demolished
- Building - standing
- Pond
- Paved road
- Stream

Aluminum
Surface Soil Background Mean
+ 2 Standard Deviations = 16715 mg/kg

Surface Soil Aluminum PRG = 24774 mg/kg

Data presented beneath buildings are results from soil samples collected at depths ranging from 0.0 to (less than or equal to ) 3.0 feet. Only the upper-most results were selected when multiple sample intervals were available. Data presented adjacent to buildings are results from surface soil samples. Data were collected from 6/29/1991 through 4/27/2005.

Some data points may lack result values due to software limitations.

DRAFT

N

Scale = 1:2500

100 0 100 200 300 400 500 600 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared for:

KAISER✦HILL COMPANY

Prepared by:

RADMS

File: W:/Projects/Fy2005/RI-FS/
Nature & Extent/Koehler-APR
WhitePaper062905/WhitePaper071105v2.apr

Date: 7/11/05

SW-A-005284


# Figure 2

## Antimony Soil Results Greater Than Background Mean + 2 Standard Deviations or WRW PRG

### KEY

- Constituent: > or = 10xPRG
- Constituent: > or = PRG and < 10xPRG
- Constituent: > Background Mean + 2 Standard Deviations and < PRG
- Building - demolished
- Building - standing
- Pond
- Paved road
- Stream

Antimony
Surface Soil Background Mean
+ 2 Standard Deviations = 0.436 mg/kg

Surface Soil Antimony PRG = 44.4 mg/kg

Data presented beneath buildings are results from soil samples collected at depths ranging from 0.0 to (less than or equal to ) 3.0 feet. Only the uppermost results were selected when multiple sample intervals were available. Data presented adjacent to buildings are results from surface soil samples. Data were collected from 6/29/1991 through 4/27/2005.

Some data points may lack result values due to software limitations.

**DRAFT**

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Scale = 1:2500

100 0 100 200 300 400 500 600 Feet

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Nature & Extent/Koehler-APR
WhitePaper062905/WhitePaper071105v2.apr

Date: 7/11/05


# Figure 3

## Arsenic Soil Results Greater Than Background Mean + 2 Standard Deviations or WRW PRG

### KEY

- Constituent: > or = 10xPRG
- Constituent: > Background Mean + 2 Standard Deviations and < 10xPRG
- Constituent: > or = PRG and < or = Background Mean + 2 Standard Deviations
- Building - demolished
- Building - standing
- Pond
- Paved road
- Stream

Arsenic
Surface Soil Background Mean + 2 Standard Deviations = 10.1 mg/kg

Surface Soil Arsenic PRG = 2.41 mg/kg

Data presented beneath buildings are results from soil samples collected at depths ranging from 0.0 to (less than or equal to ) 3.0 feet. Only the uppermost results were selected when multiple sample intervals were available. Data presented adjacent to buildings are results from surface soil samples. Data were collected from 6/29/1991 through 4/27/2005.

Some data points may lack result values due to software limitations.

DRAFT

N

Scale = 1:2500

100 0 100 200 300 400 500 600 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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Date: 7/11/05

SW-A-005284


# Figure 4

## Barium Soil Results Greater Than Background Mean + 2 Standard Deviations or WRW PRG

### KEY

- Constituent: > or = 10xPRG
- Constituent: > or = PRG and < 10xPRG
- Constituent: > Background Mean + 2 Standard Deviations and < PRG
- Building - demolished
- Building - standing
- Pond
- Paved road
- Stream

Barium
Surface Soil Background Mean
+ 2 Standard Deviations = 141.1 mg/kg

Surface Soil Barium PRG = 2872 mg/kg

Data presented beneath buildings are results from soil samples collected at depths ranging from 0.0 to (less than or equal to ) 3.0 feet. Only the upper-most results were selected when multiple sample intervals were available. Data presented adjacent to buildings are results from surface soil samples. Data were collected from 6/29/1991 through 4/27/2005.

Some data points may lack result values due to software limitations.

DRAFT

N

Scale = 1:2500

100 0 100 200 300 400 500 600 Feet

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WhitePaper062905/WhitePaper071105v2.apr Date: 7/11/05

SW-A-005284


# Figure 5

## Cadmium Soil Results Greater Than Background Mean + 2 Standard Deviations or WRW PRG

### KEY

- Constituent: > or = 10xPRG
- Constituent: > or = PRG and < 10xPRG
- Constituent: > Background Mean + 2 Standard Deviations and < PRG
- Building - demolished
- Building - standing
- Pond
- Paved road
- Stream

Cadmium
Surface Soil Background Mean
+ 2 Standard Deviations = 1.62 mg/kg

Surface Soil Cadmium PRG = 91.4 mg/kg

Data presented beneath buildings are results from soil samples collected at depths ranging from 0.0 to (less than or equal to ) 3.0 feet. Only the upper-most results were selected when multiple sample intervals were available. Data presented adjacent to buildings are results from surface soil samples. Data were collected from 6/29/1991 through 4/27/2005.

Some data points may lack result values due to software limitations.

DRAFT

N

Scale = 1:2500

100 0 100 200 300 400 500 600 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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Prepared by:

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Nature & Extent/Koehler-APR
WhitePaper062905/WhitePaper071105v2.apr Date: 7/11/05

SW-A-005284


# Figure 6

## Chromium Soil Results Greater Than Background Mean + 2 Standard Deviations or WRW PRG

### KEY

- Constituent: > or = 10xPRG
- Constituent: > or = PRG and < 10xPRG
- Constituent: > Background Mean + 2 Standard Deviations and < PRG
- Building - demolished
- Building - standing
- Pond
- Paved road
- Stream

Chromium
Surface Soil Background Mean
+ 2 Standard Deviations = 16.8 mg/kg

Surface Soil Chromium PRG = 28.4 mg/kg

Data presented beneath buildings are results from soil samples collected at depths ranging from 0.0 to (less than or equal to ) 3.0 feet. Only the uppermost results were selected when multiple sample intervals were available. Data presented adjacent to buildings are results from surface soil samples. Data were collected from 6/29/1991 through 4/27/2005.

Some data points may lack result values due to software limitations.

DRAFT

N

Scale = 1:2500

100 0 100 200 300 400 500 600 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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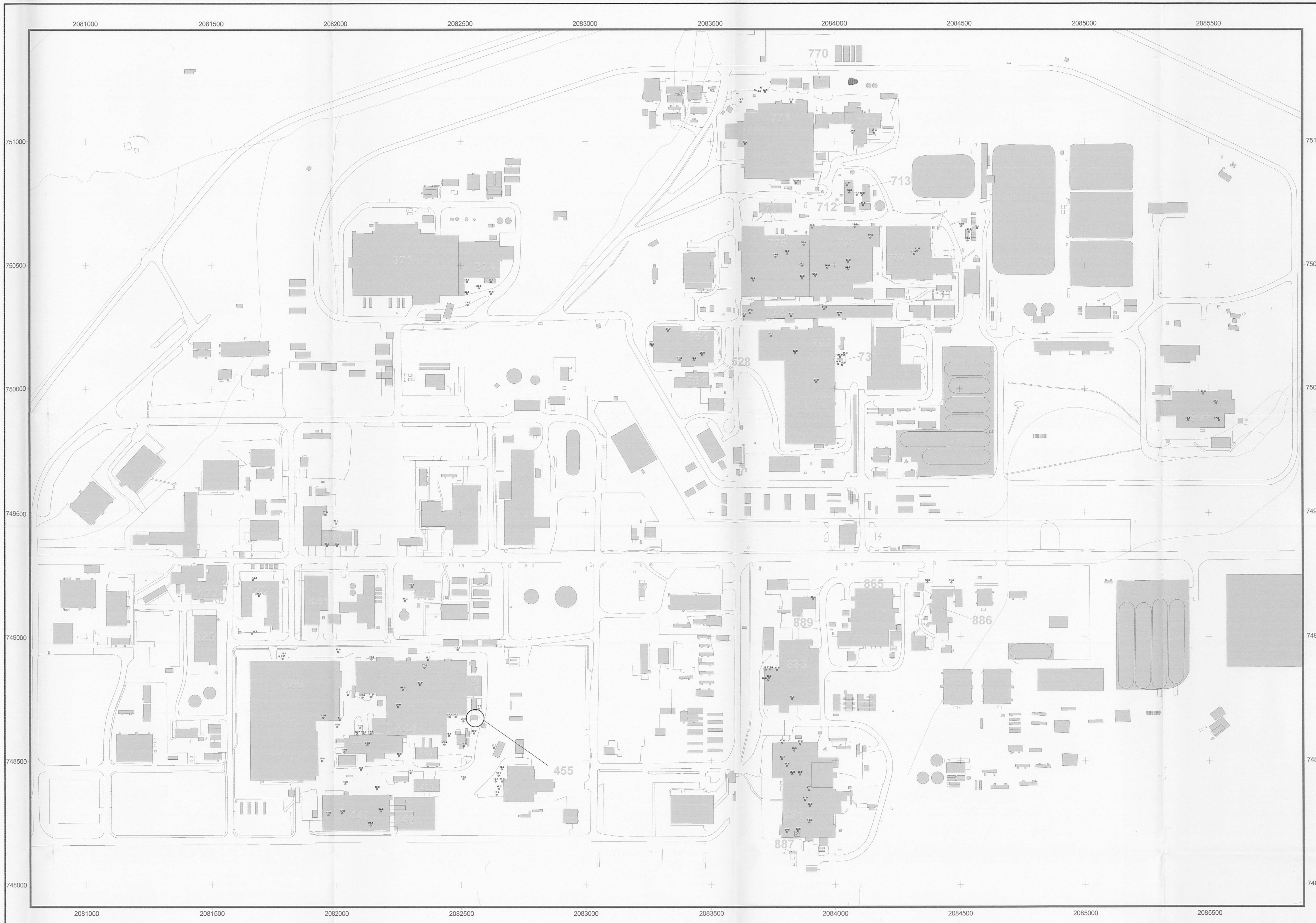
Nature & Extent/Koehler-APR
WhitePaper062905/WhitePaper071105v2.apr Date: 7/11/05

SW-A-005284




# Figure 7

## Cobalt Soil Results Greater Than Background Mean + 2 Standard Deviations or WRW PRG

### KEY

- Constituent: > or = 10xPRG
- Constituent: > or = PRG and < 10xPRG
- Constituent: > Background Mean + 2 Standard Deviations and < PRG
- Building - demolished
- Building - standing
- Pond
- Paved road
- Stream

Cobalt
Surface Soil Background Mean
+ 2 Standard Deviations = 10.9 mg/kg

Surface Soil Cobalt PRG = 122 mg/kg

Data presented beneath buildings are results from soil samples collected at depths ranging from 0.0 to (less than or equal to ) 3.0 feet. Only the uppermost results were selected when multiple sample intervals were available. Data presented adjacent to buildings are results from surface soil samples. Data were collected from 6/29/1991 through 4/27/2005.

Some data points may lack result values due to software limitations.

DRAFT

N

Scale = 1:2500

100 0 100 200 300 400 500 600 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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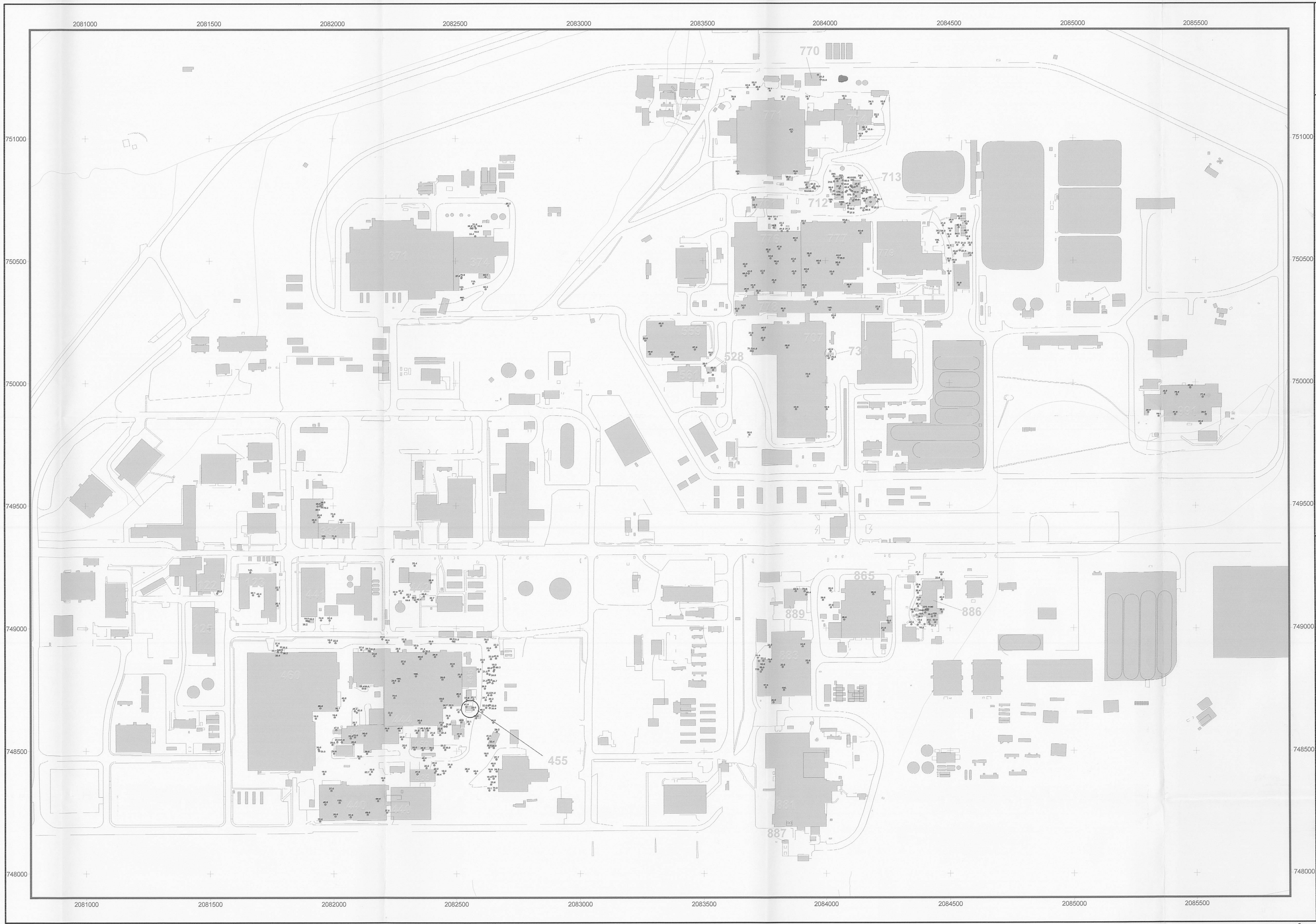
Prepared by: RADMS

File: W:/Projects/Fy2005/RI-FS/Nature & Extent/Koehler-APR WhitePaper062905/WhitePaper071105v2.apr Date: 7/11/05




# Figure 8

## Copper Soil Results Greater Than Background Mean + 2 Standard Deviations or WRW PRG

### KEY

- Constituent: > or = 10xPRG
- Constituent: > or = PRG and < 10xPRG
- Constituent: > Background Mean + 2 Standard Deviations and < PRG
- Building - demolished
- Building - standing
- Pond
- Paved road
- Stream

Copper
Surface Soil Background Mean
+ 2 Standard Deviations = 18.1 mg/kg

Surface Soil Copper PRG = 4443 mg/kg

Data presented beneath buildings are results from soil samples collected at depths ranging from 0.0 to (less than or equal to ) 3.0 feet. Only the upper-most results were selected when multiple sample intervals were available. Data presented adjacent to buildings are results from surface soil samples. Data were collected from 6/29/1991 through 4/27/2005.

Some data points may lack result values due to software limitations.

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Scale = 1:2500

100 0 100 200 300 400 500 600 Feet

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KAISER◆HILL COMPANY

Prepared by:

RADMS

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# Figure 9

## Iron Soil Results Greater Than Background Mean + 2 Standard Deviations or WRW PRG

## KEY

- Constituent: > or = 10xPRG
- Constituent: > or = PRG and < 10xPRG
- Constituent: > Background Mean + 2 Standard Deviations and < PRG
- Building - demolished
- Building - standing
- Pond
- Paved road
- Stream

Iron
Surface Soil Background Mean + 2 Standard Deviations = 17601 mg/kg

Surface Soil Iron PRG = 33326 mg/kg

Data presented beneath buildings are results from soil samples collected at depths ranging from 0.0 to (less than or equal to ) 3.0 feet. Only the upper-most results were selected when multiple sample intervals were available. Data presented adjacent to buildings are results from surface soil samples. Data were collected from 6/29/1991 through 4/27/2005.

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100 0 100 200 300 400 500 600 Feet

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# Figure 10

## Lead Soil Results Greater Than Background Mean + 2 Standard Deviations or WRW PRG

### KEY

- Constituent: > or = 10xPRG
- Constituent: > or = PRG and < 10xPRG
- Constituent: > Background Mean + 2 Standard Deviations and < PRG
- Building - demolished
- Building - standing
- Pond
- Paved road
- Stream

Lead
Surface Soil Background Mean
+ 2 Standard Deviations = 54.6 mg/kg

Surface Soil Lead PRG = 1000* mg/kg

*The PRG value for lead is not calculated, but rather is taken from EPA's "Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities" (1994).

Data presented beneath buildings are results from soil samples collected at depths ranging from 0.0 to (less than or equal to ) 3.0 feet. Only the uppermost results were selected when multiple sample intervals were available. Data presented adjacent to buildings are results from surface soil samples. Data were collected from 6/29/1991 through 4/27/2005.

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# Figure 11

## Lithium Soil Results Greater Than Background Mean + 2 Standard Deviations or WRW PRG

### KEY

- Constituent: > or = 10xPRG
- Constituent: > or = PRG and < 10xPRG
- Constituent: > Background Mean + 2 Standard Deviations and < PRG
- Building - demolished
- Building - standing
- Pond
- Paved road
- Stream

Lithium
Surface Soil Background Mean
+ 2 Standard Deviations = 11.44 mg/kg

Surface Soil Lithium PRG = 2222 mg/kg

Data presented beneath buildings are results from soil samples collected at depths ranging from 0.0 to (less than or equal to ) 3.0 feet. Only the upper-most results were selected when multiple sample intervals were available. Data presented adjacent to buildings are results from surface soil samples. Data were collected from 6/29/1991 through 4/27/2005.

Some data points may lack result values due to software limitations.

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Scale = 1:2500

100 0 100 200 300 400 500 600 Feet

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# Figure 12

## Manganese Soil Results Greater Than Background Mean + 2 Standard Deviations or WRW PRG

### KEY

- Constituent: > or = 10xPRG
- Constituent: > or = PRG and < 10xPRG
- Constituent: > Background Mean + 2 Standard Deviations and < PRG
- Building - demolished
- Building - standing
- Pond
- Paved road
- Stream

Manganese
Surface Soil Background Mean
+ 2 Standard Deviations = 365 mg/kg

Surface Soil Manganese PRG = 419 mg/kg

Data presented beneath buildings are results from soil samples collected at depths ranging from 0.0 to (less than or equal to ) 3.0 feet. Only the uppermost results were selected when multiple sample intervals were available. Data presented adjacent to buildings are results from surface soil samples. Data were collected from 6/29/1991 through 4/27/2005.

Some data points may lack result values due to software limitations.

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Scale = 1:2500

100 0 100 200 300 400 500 600 Feet

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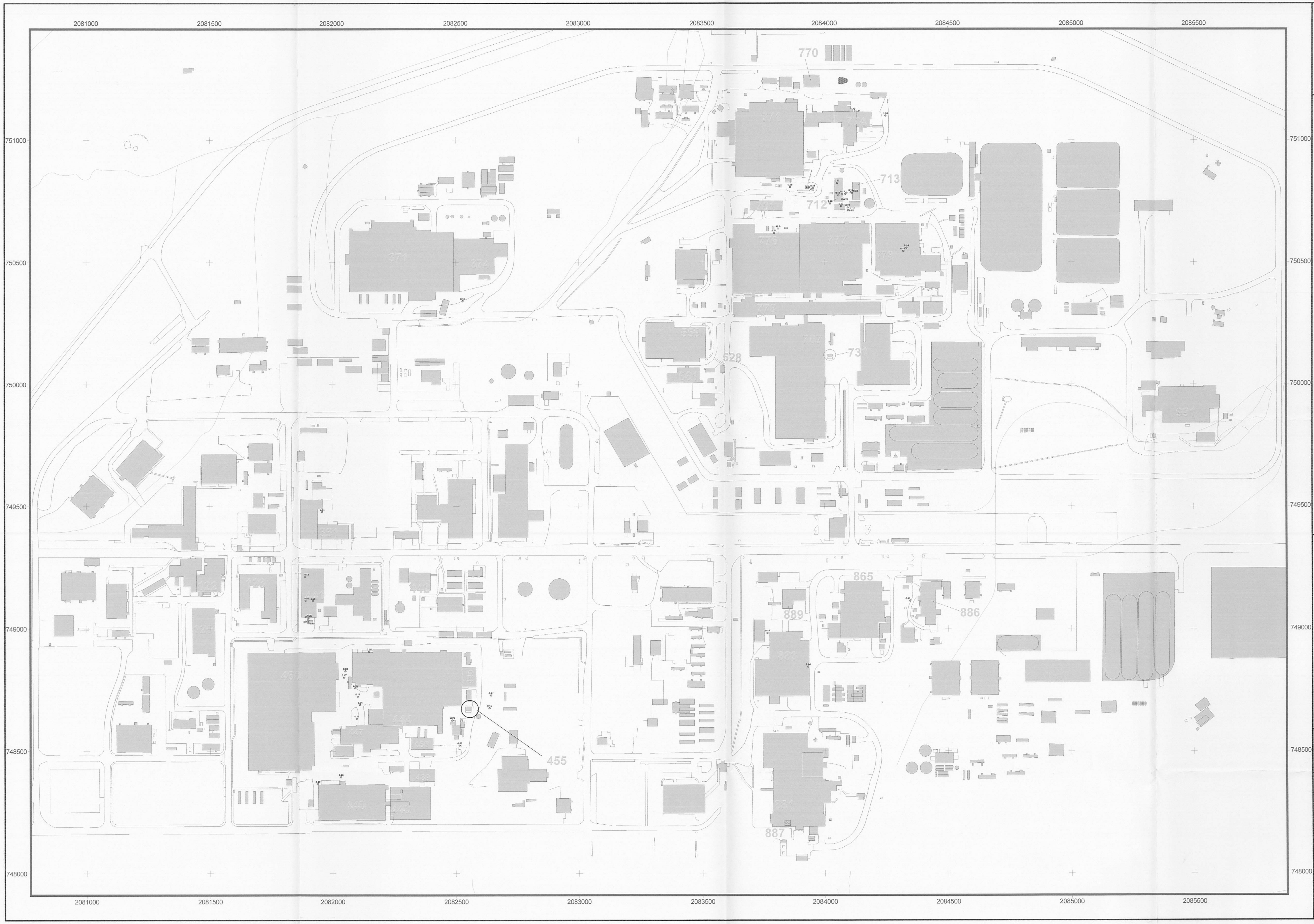


# Figure 13

## Mercury Soil Results Greater Than Background Mean + 2 Standard Deviations or WRW PRG

### KEY

- Constituent: > or = 10xPRG
- Constituent: > or = PRG and < 10xPRG
- Constituent: > Background Mean + 2 Standard Deviations and < PRG
- Building - demolished
- Building - standing
- Pond
- Paved road
- Stream

Mercury
Surface Soil Background Mean
+ 2 Standard Deviations = 0.13 mg/kg

Surface Soil Mercury PRG = 32.9 mg/kg

Data presented beneath buildings are results from soil samples collected at depths ranging from 0.0 to (less than or equal to ) 3.0 feet. Only the uppermost results were selected when multiple sample intervals were available. Data presented adjacent to buildings are results from surface soil samples. Data were collected from 6/29/1991 through 4/27/2005.

Some data points may lack result values due to software limitations.

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Date: 7/11/05


# Figure 14

## Molybdenum Soil Results Greater Than Background Mean + 2 Standard Deviations or WRW PRG

### KEY

- Constituent: > or = 10xPRG
- Constituent: > or = PRG and < 10xPRG
- Constituent: > Background Mean + 2 Standard Deviations and < PRG
- Building - demolished
- Building - standing
- Pond
- Paved road
- Stream

Molybdenum
Surface Soil Background Mean
+ 2 Standard Deviations = 0.941 mg/kg

Surface Soil Molybdenum PRG = 555 mg/kg

Data presented beneath buildings are results from soil samples collected at depths ranging from 0.0 to (less than or equal to ) 3.0 feet. Only the uppermost results were selected when multiple sample intervals were available. Data presented adjacent to buildings are results from surface soil samples. Data were collected from 6/29/1991 through 4/27/2005.

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Scale = 1:2500

100 0 100 200 300 400 500 600 Feet

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# Figure 15

## Nickel Soil Results Greater Than Background Mean + 2 Standard Deviations or WRW PRG

### KEY

- Constituent: > or = 10xPRG
- Constituent: > or = PRG and < 10xPRG
- Constituent: > Background Mean + 2 Standard Deviations and < PRG
- Building - demolished
- Building - standing
- Pond
- Paved road
- Stream

Nickel
Surface Soil Background Mean
+ 2 Standard Deviations = 14.79 mg/kg

Surface Soil Nickel PRG = 2221 mg/kg

Data presented beneath buildings are results from soil samples collected at depths ranging from 0.0 to (less than or equal to ) 3.0 feet. Only the upper-most results were selected when multiple sample intervals were available. Data presented adjacent to buildings are results from surface soil samples. Data were collected from 6/29/1991 through 4/27/2005.

Some data points may lack result values due to software limitations.

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Scale = 1:2500

100 0 100 200 300 400 500 600 Feet

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# Figure 16

## Selenium Soil Results Greater Than Background Mean + 2 Standard Deviations or WRW PRG

### KEY

- Constituent: > or = 10xPRG
- Constituent: > or = PRG and < 10xPRG
- Constituent: > Background Mean + 2 Standard Deviations and < PRG
- Building - demolished
- Building - standing
- Pond
- Paved road
- Stream

Selenium
Surface Soil Background Mean
+ 2 Standard Deviations = 1.24 mg/kg

Surface Soil Selenium PRG = 555 mg/kg

Data presented beneath buildings are results from soil samples collected at depths ranging from 0.0 to (less than or equal to ) 3.0 feet. Only the uppermost results were selected when multiple sample intervals were available. Data presented adjacent to buildings are results from surface soil samples. Data were collected from 6/29/1991 through 4/27/2005.

Some data points may lack result values due to software limitations.

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100 0 100 200 300 400 500 600 Feet

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# Figure 17

## Strontium Soil Results Greater Than Background Mean + 2 Standard Deviations or WRW PRG

### KEY

- Constituent: > or = 10xPRG
- Constituent: > or = PRG and < 10xPRG
- Constituent: > Background Mean + 2 Standard Deviations and < PRG
- Building - demolished
- Building - standing
- Pond
- Paved road
- Stream

Strontium
Surface Soil Background Mean
+ 2 Standard Deviations = 48.8 mg/kg

Surface Soil Strontium PRG = 66652 mg/kg

Data presented beneath buildings are results from soil samples collected at depths ranging from 0.0 to (less than or equal to ) 3.0 feet. Only the uppermost results were selected when multiple sample intervals were available. Data presented adjacent to buildings are results from surface soil samples. Data were collected from 6/29/1991 through 4/27/2005.

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Scale = 1:2500

100 0 100 200 300 400 500 600 Feet

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## Vanadium Soil Results Greater Than Background Mean + 2 Standard Deviations or WRW PRG


### KEY

- Constituent: > or = 10xPRG
- Constituent: > or = PRG and < 10xPRG
- Constituent: > Background Mean + 2 Standard Deviations and < PRG
- Building - demolished
- Building - standing
- Pond
- Paved road
- Stream

Vanadium
Surface Soil Background Mean + 2 Standard Deviations = 43.1 mg/kg

Surface Soil Vanadium PRG = 111 mg/kg

Data presented beneath buildings are results from soil samples collected at depths ranging from 0.0 to (less than or equal to ) 3.0 feet. Only the uppermost results were selected when multiple sample intervals were available. Data presented adjacent to buildings are results from surface soil samples. Data were collected from 6/29/1991 through 4/27/2005.

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SW-A-005284
19 of 22


# Figure 20

## Zinc Soil Results Greater Than Background Mean + 2 Standard Deviations or WRW PRG

## KEY

- Constituent: > or = 10xPRG
- Constituent: > or = PRG and < 10xPRG
- Constituent: > Background Mean + 2 Standard Deviations and < PRG
- Building - demolished
- Building - standing
- Pond
- Paved road
- Stream

Zinc
Surface Soil Background Mean + 2 Standard Deviations = 74.2 mg/kg

Surface Soil Zinc PRG = 33326 mg/kg

Data presented beneath buildings are results from soil samples collected at depths ranging from 0.0 to (less than or equal to ) 3.0 feet. Only the upper-most results were selected when multiple sample intervals were available. Data presented adjacent to buildings are results from surface soil samples. Data were collected from 6/29/1991 through 4/27/2005.

Some data points may lack result values due to software limitations.

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Scale = 1:2500

100 0 100 200 300 400 500 600 Feet

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## Figure 22

## Radium-228 Soil Results Greater Than Background Mean + 2 Standard Deviations or WRW PRG


### KEY

- Constituent: > Background Mean + 2 Standard Deviations
- Constituent: > or = 10xPRG and < or = Background Mean + 2 Standard Deviations
- Constituent: > or = PRG and < 10xPRG
- Building - demolished
- Building - standing
- Pond
- Paved road
- Stream

Radium-228
Surface Soil Background Mean
+ 2 Standard Deviations = 2.31 pCi/g

Surface Soil Radium-228 PRG = 0.11 pCi/g

Data presented beneath buildings are results from soil samples collected at depths ranging from 0.0 to (less than or equal to ) 3.0 feet. Only the uppermost results were selected when multiple sample intervals were available. Data presented adjacent to buildings are results from surface soil samples. Data were collected from 6/29/1991 through 4/27/2005.

Some data points may lack result values due to software limitations.

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Scale = 1:2500

100 0 100 200 300 400 500 600 Feet

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# Figure 22

## Radium-228 Soil Results Greater Than Background Mean + 2 Standard Deviations or WRW PRG

### KEY

- Constituent: > Background Mean + 2 Standard Deviations
- Constituent: > or = 10xPRG and < or = Background Mean + 2 Standard Deviations
- Constituent: > or = PRG and < 10xPRG
- Building - demolished
- Building - standing
- Pond
- Paved road
- Stream

Radium-228
Surface Soil Background Mean
+ 2 Standard Deviations = 2.31 pCi/g

Surface Soil Radium-228 PRG = 0.11 pCi/g

Data presented beneath buildings are results from soil samples collected at depths ranging from 0.0 to (less than or equal to ) 3.0 feet. Only the uppermost results were selected when multiple sample intervals were available. Data presented adjacent to buildings are results from surface soil samples. Data were collected from 6/29/1991 through 4/27/2005.

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